Interreg CENTRAL EUROPE

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CURIOST

Circular design and development of sustainable products in 4 key sectors in Central Europe

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1. Evaluation of regional needs and guidance for action planning

DELIVERABLE 3.3.1.

INTRODUCTION

Deliverable 3.3.1. Evaluation of regional needs and guidance for action planning is foreseen to be a key input for "regional chapters" in the jointly developed action plan. Considering strategic results of activities *A1.1. Approaching a common understanding of current status* and *A3.1. Integrated strategic framework*, this template offers guidance for mapping the regional needs of SMEs and small midcaps in the 4 targeted manufacturing sectors in each partner region/country. This template can be considered as a step closer towards making of CURIOST Action Plan.

About

Within the CURIOST project, each partner had conducted an analysis of S3/circular economy policies, European regulatory framework and status of sustainability practices in the companies in four targeted sectors as well as refining best practices examples from relevant areas in project partner regions/countries. These activities will help to formulate CURIOST Action Plan. Currently the evaluation of regional needs and guidance for action planning is based on the following inputs:

- D 1.1.1 State of the art in sustainable and (digital) circular product development
- D 1.1.2 Gaps and challenges analysis for digital and circular design in sustainable product development
- D 1.1.3 Capitalization of best practices and benchmarks in sustainable product design in Central Europe
- D 3.1.1 Analysis of S3 strategies in the participating regions/ countries
- D 3.1.2. Analysis of latest legal + policy framework on EU level

CURIOST Action Plan will present recommended key measures to support the uptake of sustainable product development solutions by SMEs and small midcaps to the whole

Central European project level, addressing the level of policy- makers and governance institutions.

As a key contribution to the jointly developed CURIOST Action Plan, specific regional needs are being assessed for each partner region, considering the inputs of A1.1 and A3.1. Specific actions to address the concrete needs of each partner region/country are proposed in the Catalogue of concrete actions and will be included in “regional chapters” of the Action Plan. In the same way specific needs of 4 sectors; mechanics and mechatronics, packaging, plastics and construction and building are addressed with appropriate actions listed in the document “Catalogue of concrete actions”, according to partners inputs. The analysis conducted by the project partnership represents the starting point for the development of one CURIOST Action Plan that will include all project partner regions. The geographical scope of the Action Plan are Central European countries: Austria, Germany, Poland, Slovakia, Croatia, Italy, Hungary. Proposed actions for regions and sectors will be discussed among project partners to refine CURIOST Action Plan, which will be shared with associated partners and other key stakeholders through policy meets business activities and communication activities.

2. AUSTRIA - REGIONAL ANALYSIS



Austria has long been recognized for its commitment to circular economy and sustainability. The success in the process is arising from close collaboration and joint efforts of two largest federal states: Lower Austria and Upper Austria. While each region possesses unique economic strengths and environmental priorities, their interconnectedness offers a fertile ground for innovation and the scaling of sustainable solutions.

Upper Austria is recognized as the leading industrial state in Austria. It is home to a significant portion of the country's industrial production and employment, making it a key driver of the national economy. Unfortunately, as many regions and countries of Europe, working-age population of Upper Austria is declining. This demographic shift is projected to result in a shortage of 127,000 skilled workers by 2030. That is why the new strategy "Arbeitsplatz OÖ 2030" focuses on qualification, activation of the existing workforce potential, and the recruitment and retention of skilled workers to support technological progress and digitalization. Intercultural competencies and foreign languages are also emphasized.

Lower Austria encourages innovative, high-quality production and products, digitalization and developments made to protect climate and environment. Objectives are set to transform Lower Austria as the region that can be a highly innovative business location supporting sustainable growth. Lower Austria is home to numerous manufacturing companies and innovative enterprises that create products and services. In the context of CURIOST project and in Lower Austrian economic strategy as well, intelligent and innovative, high-quality products are drivers of international competitiveness. To achieve all other objectives and goals, significant governmental support and restructuring will be

necessary, especially for traditional companies and approaches. Technology and innovation programmes will provide support for innovation labs, start-up indicators, programmes for networking and developing technologies. Business development will provide advice and support for export and internationalization matters, while financing products support investments and innovation funding and modern financing products. Since the region is rich with enterprises in wide range of industries and business models, Lower Austria favours a horizontal industry policy approach over a sector- specific one.

Strategic goals in efficient and circular economy:

- Maintaining and expanding the technological lead of companies at the location to continue successfully placing innovative products and services in national and international markets.
- Increasing the efficiency of Upper Austria's economy and industry, and positioning Upper Austria as a region for "Responsible Technologies & Management"
- To tackle future challenges in Upper Austria's economic and research sectors, key technologies and core competencies in mechatronics, materials, and information and communication technology will be continuously developed.
- Integrating existing technologies will generate new knowledge through research, with a focus on rapid application. Information and communication technology is vital in a digital economy, aiming to convert data into value. Prioritizing new technologies like AI and data-driven modelling will enhance various applications.
- Innovations in materials will combine traditional and digital methods for safe, durable, and recyclable products. Mechatronics will optimize processes and products using advanced technologies. Technical innovations will require interdisciplinary expertise, incorporating societal, ethical, legal, and artistic aspects early in the process.

Key points for achieving an efficient and circular economy are to ensure supply security and affordability and environmental compatibility to reduce fossil fuel consumption. In detail:

- Technological flexibility: Developing processes to increase flexibility in raw material usage and enable cascading or coupled use of raw and residual materials for added value.

- Efficiency and sustainability: Enhancing process and production efficiency and sustainability using new technologies like Big Data, AI, and data-driven modeling, under the concept of "Responsible Technologies."
- Recycling and lifecycle: Incorporating component reuse and recyclability into holistic product lifecycle design.
- Energy focus: Concentrating on energy storage, distribution, and efficient consumption, and integrating sectors like electricity, heat, transport, and industry through new technologies and system innovations.

Relevant strategic flagship project in Upper Austria: “Kunststoffstandort 2030+:

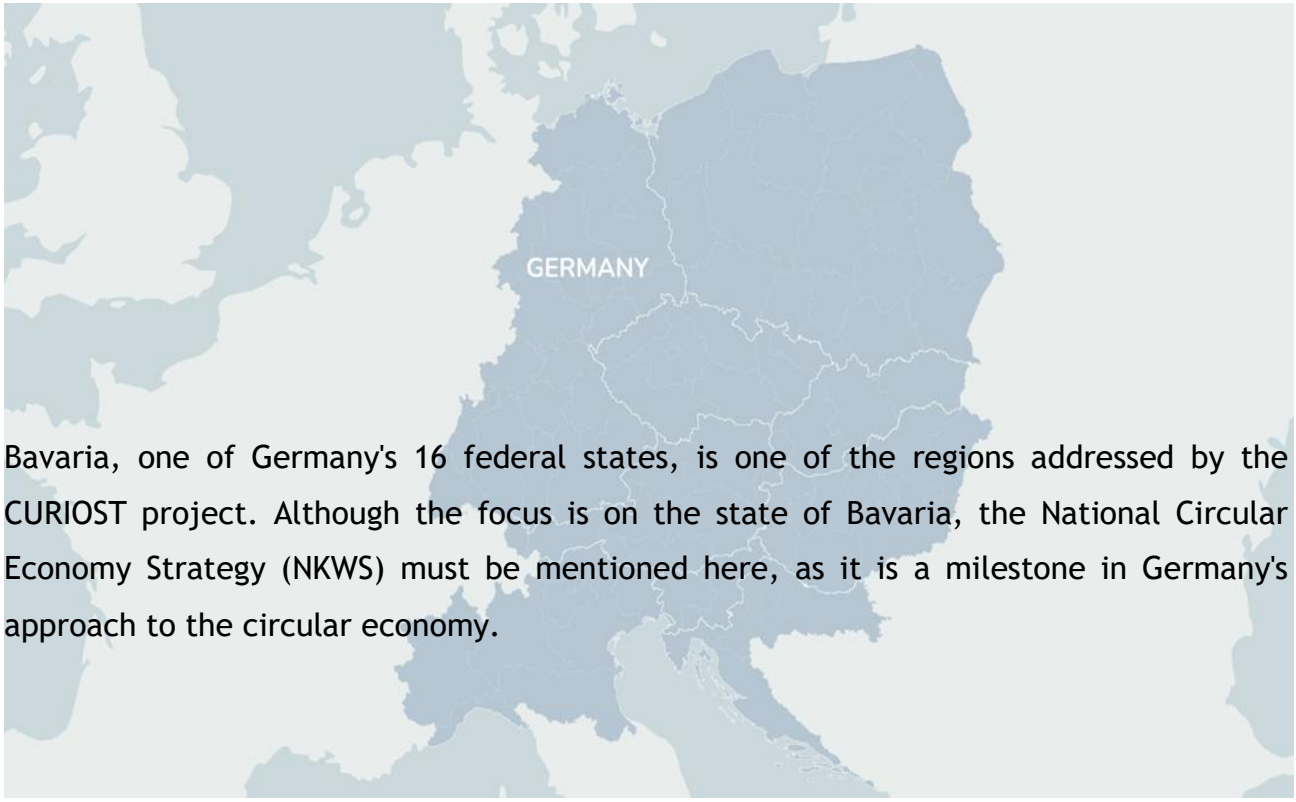
- Promoting a Positive Image of Plastics
  - Improve the perception of plastics through education and transparent communication.
  - Highlight the diverse applications and ecological aspects of plastics.
  - Focus on reducing plastic waste with innovative technologies.
- Transitioning to a Circular Economy:
  - Replace the linear economic model in the plastics industry with a circular one.
  - Promote research and development of innovative recycling technologies.
  - Establish closed loops for plastic products and implement sustainable production processes.
  - Ensure plastics are designed for circularity, efficiently used, and resource-conserving recycled.

2.1. Specific sectoral needs in Austria

- Expertise and Skills needed: Specialists in (digital) circular product development and advanced technological skills are crucial for economic success, including experience in metalworking, mechatronics, and digitalization.
- Sustainability Commitment needed: Strong internal commitment to sustainability enhances a company's image and reputation, gaining stakeholder trust and positioning as reliable players.
- Transformation Levels: Most companies are at transformation levels 1 and 2, lagging other sectors in adopting circular economy practices.

- Collaboration and Support needed: Cooperation, partnerships, and regulatory support from other companies, institutions, and political frameworks are essential.
- Financial Challenges: Investing in innovative technologies is key but challenging, including advancements in production and new digital business models.
- Strategic Prioritization: Many companies have not prioritized the circular economy strategically, leading to slow implementation of changes and innovations.
- Traditional Mindsets: Slow adaptation of processes due to traditional mindsets hinders rapid adoption of sustainable practices.
- Economic Uncertainties: Economic fluctuations and uncertainties in financing sustainable measures pose significant obstacles, including market volatility and price pressure
- In line with European regulations dealing with plastics and packaging, reducing packaging material and increasing the share that is reusable, as well as introducing sustainable design of plastic products, similar measures will be encouraged in Austria. Further on, federal standardization of the packaging collection, separate collection of plastics and packaging will be introduced, with expansion and modernization of sorting facilities. From 2025 Austria introduced the deposit system for plastic bottles.
- In mechanics and mechatronics sector, to establish a future sustainable, resource- efficient industry Austria needs to focus on faster transfer to circular economy to achieve change in the market regarding production, use and recycling. Through this support, this strategy fosters innovation and technological development, driving innovation and creating new business opportunities.
- Construction and building: it aims to make buildings more durable through maintenance and renovation with emphasis on energy efficiency. Components should be reusable and easier to recycle, with using more recycled materials in construction and designing buildings that can be easily taken apart and reused.

3. BAVARIA (GERMANY) – REGIONAL ANALYSIS



Bavaria, one of Germany's 16 federal states, is one of the regions addressed by the CURIOST project. Although the focus is on the state of Bavaria, the National Circular Economy Strategy (NKWS) must be mentioned here, as it is a milestone in Germany's approach to the circular economy.

This strategy, which was completed in December 2024, sets ambitious goals for reducing the consumption of primary raw materials and closing material cycles. For example, only 13 per cent of the materials used today are secondary raw materials. The aim is to double this figure by 2030, in line with the EU's objective. Another example is waste reduction: 10 per cent less waste per capita by 2030 and 20 per cent less by 2045, both compared to 2020. More information on the NKWS can be found here. In addition to the NKWS, the Free State of Bavaria decided in July 2024 to develop a Bavarian Circular Economy Strategy (BayKWS). The development of a BayKWS is intended to pave the way for a sustainable and resource-conserving economic system in Bavaria and thus create a clear orientation for the Bavarian economy. In this important priority area, the Free State of Bavaria is relying on voluntarism, self-responsibility and cooperation. government. For this reason, the BayKWS is being developed in close cooperation between industry and the state government. A regional Bavarian strategy can specifically address the local economic structure to meet the different requirements and potentials of the sectors. BayKWS focuses on six different sectors, including “mobility”, “metal & mechanical engineering”, “construction & infrastructure” and “plastics & packaging”.

In addition to the NKWS, the federal state of Bavaria decided in July 2024 to develop a Bavarian Circular Economy Strategy (BayKWS). The development of a BayKWS is intended to pave the way for a sustainable and resource-conserving economic system in Bavaria and thus create a clear orientation for the Bavarian economy. The Free State of Bavaria relies on voluntarism, personal responsibility and cooperation in this important priority area. This is why BayKWS is being developed in close cooperation between industry and the state. A regional Bavarian strategy can specifically address the local economic structure to meet the different requirements and potentials of the sectors. BayKWS focuses on six different sectors including “mobility, metals & mechanical engineering”, “construction & infrastructure” and “plastics & packaging”.

The Bavarian State Ministry of the Environment and Consumer Protection (Department 78 - Resource Efficiency, Waste Prevention and Recycling, Product Stewardship) organised sector-specific stakeholder dialogs at the beginning of 2025. The aim of these dialogues was to discuss challenges and solutions that could be included in the BayKWS. The Resource Efficiency Centre of Bavaria (REZ) is responsible for the central coordination of the successful development and implementation of the BayKWS. More information on the BayKWS can be found here.

Within the CURIOST project, the Bavarian project partners Bayern Innovation (BI) and UCB (Umweltcluster Bayern - Cluster of Environmental Technology Bavaria) focus on the sectors mechanics and mechatronics, plastics and construction. As the BayKWS covers these sectors, the content of the BayKWS will be of high relevance for CURIOST as well as for the Bavarian companies in these sectors. BI and UCB participated in all stakeholder dialogues for the development of the BayKWS. Unfortunately, the BayKWS is not yet finalised at the time of this evaluation. However, the measures defined in the CURIOST action plan should contribute to the implementation of the goals defined in the BayKWS.

In addition, the "Mission RC20/25", which is of great relevance to the construction sector, is to be mentioned in this context. In order to strengthen this awareness and to exploit the potential of recycled building materials, the Bavarian state government adopted the "Mission RC20/25 - Bavaria sets on environmental protection" package of measures for the increased use of recycled building materials on 29 March 2022.The Free State of Bavaria aims to increase the proportion of construction waste processed in recycling plants by 20 per cent by 2025, viewing this as a task for society as a whole. The Free State of Bavaria

will act as a role model by promoting the use of recycled building materials in construction projects carried out by the Free State as far as is technically and economically feasible, by encouraging Bavarian local authorities to adopt the same approach, by proposing to all departments exemplary projects or construction projects that can be carried out using recycled building materials, and by promoting recycled building materials in the context of urban development. More details about the "Mission RC20/25" can be found here.

Both the federal government of Germany and the state government of Bavaria have defined, or are in the process of developing, circular economy strategies featuring specific goals, indicators, and measures. Effectively putting these strategies into practice and meeting the targets presents the key challenge, demanding engagement from both the business sector and the wider public.

Currently, the main cross-sectoral challenges for implementing CiE activities which were identified in A3.1. and A1.1 are:

- **Financial Constraints**: SMEs often face difficulties in obtaining financial support from government or EU initiatives for essential initial investments.
- **Administrative Burdens**: Significant documentation requirements and excessive bureaucracy can significantly hinder the adoption of sustainable practices.
- **Regulatory Disadvantages**: Strict EU regulations may create a competitive disadvantage for businesses within the EU on the global market. This is further compounded by imported products from non-EU countries that may not adhere to the same environmental administrative obstacles, e.g. enormous documentation requirements / excessive bureaucracy can hinder the implementation of sustainable measures
- **Limited Awareness of Circular Economy Benefits**: Many SMEs lack a comprehensive understanding of the importance of the circular economy. Consequently, economic growth targets are frequently pursued without adequate consideration of environmental impacts.

3.1. Specific sectoral needs in Bavaria

Within the CURIOST project, the Bavarian project partners BI and UCB are focusing on the mechanics and mechatronics, plastics and construction sectors. These three sectors are of high relevance for the Free State of Bavaria.

The CURIOST reports A1.1 and A1.2 have identified various challenges for implementing CiE activities within these three sectors. In the following section, two sector-specific obstacles that were identified as being highly relevant for the sector, as well as for possible activities with CURIOST, are presented. These obstacles are also accompanied by the definition of priority intervention areas and actions.

Mechanic & Mechatronic

- difficulties in implementing take-back systems, e.g. of broken components: obstacles such as high transportation costs, import/export regulations and additional effort within the companies (the costumer needs to send back the components; the manufacture needs to recondition / recycle the parts)
- limited acceptance and lack of knowledge or resources of using 3D printing technologies and AI supported technologies to e.g. reduce production waste and save resources for prototype development

Plastics

- **Low acceptance of recycled materials:** Decision-makers, such as CEOs and designers, often show limited inclination to use recycled materials due to concerns about reduced quality and higher costs. Additionally, there is limited flexibility regarding material requirements, such as color.
- **Underutilization of sustainable bioplastics:** The potential of biobased plastics as a sustainable alternative to fossil-based plastics is not fully realized. Their effectiveness depends on sourcing conditions and recycling options. To fully harness their potential, increased investments, research, and awareness at both company and consumer levels are essential.

Construction

- **Cost intensity**: The high costs associated with circular buildings and the economic unprofitability of recycling measures for construction waste, especially when material yields are low, present significant challenges.
- **Complex legal framework:** Overregulation and complicated approval procedures hinder the implementation and development of recycling projects.

The project partners in Bavaria, BI and UCB, are focusing on sector-specific priority intervention areas, on the assumption that these will lead to more impact. The regional focus of the priority intervention areas is the Free State of Bavaria.

4. CROATIA - REGIONAL ANALYSIS

Croatia's main strategic priorities at the political level for sustainable production and the circular economy are outlined through national frameworks, sector-specific initiatives, and alignment with EU regulations. These priorities aim to foster innovation, resource efficiency, and environmental sustainability, in line with Croatia's National Development Strategy 2030 and the EUs "Smarter Europe" Goals, which emphasize innovation, green transitions, and regional industrial modernization. For Croatia, two regions were analysed, North Croatian region and Primorje – Gorski Kotar County, by two partners Metalska Jezgra Čakovec and STEP RI.



Croatia's Smart Specialisation Strategy (S3) 2021–2029 serves as a cornerstone of the country's innovation and industrial transformation agenda. It outlines five thematic priority areas (TPAs):

- Health and quality of life;
- Energy and sustainable environment;
- Transport and mobility;

- Security;
- Food and bioeconomy.

These TPAs aim to improve competitiveness, foster innovation-driven growth, and accelerate green and digital transitions. To address regional disparities in innovation and industrial modernization, Croatia has developed Industrial Transition Plans (ITPs) for its three NUTS 2 regions—Pannonian, Adriatic, and Northern Croatia. These plans, part of the Integrated Territorial Programme 2021–2027, aim to boost economic resilience, improve innovation capacity, and guide investments in digital and green transitions. They serve as a basis for regionally tailored support, particularly in less developed areas below 75% of EU GDP per capita: These ITPs align with S3 priorities and create new opportunities for deploying circular business models in the key sectors addressed by CURIOST, including construction, plastics, packaging, and mechatronics. However, their effective implementation depends on stronger cross-sectoral collaboration, better coordination between regional stakeholders, and targeted capacity-building for SMEs.

Croatia's regional context is shaped by both strengths and systemic challenges:

- Strong alignment with EU climate, energy, and circularity goals.
- Clear strategic direction via S3 and development plans.
- Emerging best practices in circular product innovation (as mapped in A.1.3).
- Fragmented implementation across sectors and governance levels.
- Limited circular economy uptake among SMEs.
- Underdeveloped infrastructure for secondary raw materials and eco-design.
- Gaps in SME-targeted support for transitioning toward sustainable products.

These findings form the contextual basis for identifying Croatia's priority intervention areas and action planning in the next phases of the CURIOST project.

Some of the most important Croatian policies endosring transformation to circular economy include Waste Management Plan (2023-2028), Circular Economy Action Plan for Construction and Demolition Waste (2022- 2026), National Development Strategy 2030 prioritizing a green and circular economy, sector specific measures and emphasizing Integration of Digital Technologies with Digital Croatia Strategy 2032.

4.1. Specific sectoral needs in Croatia

Concerning sector specific needs the partners identified that Croatia's circular economy transition requires targeted interventions across key sectors to address systemic gaps and leverage emerging opportunities. Both partners focus on three sectors; construction and building, mechanics/mechatronics and plastics.

The regional construction sector shows early steps toward circular transformation, particularly in material reuse and energy-efficient production. While comprehensive regional data on the sector's involvement in circular practices is limited to a sample of best practices, local examples demonstrate promising initiatives in material innovation and recycling—especially in the use of recycled asphalt for road surfaces and water-based waterproofing solutions in construction materials. These examples stem primarily from research institutions and SMEs experimenting with low-carbon materials and energy-efficient processes. Croatia's construction sector requires training programs for architects and engineers on circular principles to bridge existing skills gaps, comply with EU regulations, and adopt sustainable practices effectively. These programs will play a pivotal role in achieving national sustainability goals while enhancing competitiveness within the European market. Vocational training programs currently focus on energy efficiency but do not adequately cover circular economy principles like deconstruction, bio-based materials, or waste minimization strategies.

The regional plastics sector best practices includes SMEs engaged in the production of consumer goods, packaging components, and technical parts for sanitary systems. While the sector is subject to increasing regulatory and market pressure to improve its environmental performance, circular transformation is still at an early stage. As for innovation in Circular Product Design Biodegradable plastic production remains limited, R&D funding for such innovations remains limited with only 8% of NRRP funds allocated to circular SMEs. Croatian firms need support to develop reusable or refillable packaging systems, aligning with EU goals to reduce single-use plastics. Regarding consumer education and awareness a recent survey revealed that 62% of households do not separate plastic waste due to unclear guidelines and lack of awareness campaigns. Nationwide education initiatives are needed to encourage proper waste segregation and recycling habits.

The regional mechanics and mechatronics sector includes SMEs engaged in metalworking, process automation, and industrial system maintenance. These companies often operate across multiple industries and are known for their focus on performance, reliability, and technological competence. Although circularity is not yet a strategic priority for most of these firms, several of their existing practices—such as long product lifespans, energy-efficient upgrades, and integrated maintenance services—have the potential to evolve into circular business models. It is identified that companies posess the technological base to support circular transformaton, but lack dedicated incentives, knowledge or custromer demand to justify the shift.

5. PIEDMONT REGION (ITALY) - REGIONAL ANALYSIS

The Smart Specialisation Strategy (S3) for the Piedmont region is a key driver of innovation and sustainable economic growth, addressing sector-specific needs, fostering collaboration, and promoting research and development. Piedmont's S3 focuses on leveraging regional strengths in key sectors such as aerospace, mobility, advanced manufacturing, medical technologies, innovative textiles, and advanced materials for batteries. Thematic platforms and partnerships facilitate targeted innovation, ensuring that businesses, research institutions, and policymakers work in synergy to maximize impact.



A robust governance and monitoring system supports the continuous refinement of the strategy. Key institutions such as NUVAL (Piedmont Region's Public Investment Assessment and Verification Unit) and IRES (Institute for Socio-Economic Research) provide data-driven insights, ensuring that S3 remains aligned with real-time regional needs. Regular evaluations help integrate feedback from stakeholders, maintaining the strategy's responsiveness and effectiveness.

S3 also plays a fundamental role in the circular economy transition, particularly through investments in green technologies, the bioeconomy, and low-carbon innovations. This aligns with the European Green Deal and broader EU sustainability objectives, reinforcing Piedmont's position as a leader in sustainable industrial transformation.

In addition to S3, Piedmont's Regional Sustainable Development Strategy (SRSvS) aligns with national and European sustainability goals, particularly those set out in the EU Circular Economy Action Plan and Agenda 2030. The Documento Strategico Unitario (DSU) ensures coherence between different policy frameworks, strengthening Piedmont's approach to sustainability and resource efficiency.

At the national level, the Italian National Strategy for the Circular Economy provides a comprehensive framework to drive circular business models, enhance waste reduction, and foster secondary raw material markets. This strategy supports regional implementation through financial incentives, regulatory measures, and capacity-building initiatives, ensuring a smooth transition of local industries to circular and sustainable production practices.

Key policy measures include:

- Development of secondary raw materials markets to reduce reliance on virgin materials.
- Fiscal incentives and subsidies to encourage eco-design, industrial symbiosis, and resource efficiency.
- Regulatory frameworks to promote recycling, reuse, and extended producer responsibility schemes.
- Support for green chemistry and advanced materials, particularly relevant to Piedmont's strong industrial base.

Despite significant advancements, Piedmont faces several challenges in accelerating the transition to a circular economy:

- Investment in innovation: continuous funding is needed to support R&D in sustainable materials and processes.
- SME engagement: while large companies often lead the way, ensuring small and medium-sized enterprises have access to knowledge, financing, and best practices remains crucial.

- Regulatory alignment: harmonizing regional, national, and EU regulations can be complex, requiring greater coordination and policy coherence.
- Skills development: Reskilling and upskilling the workforce are essential to meet the demands of emerging circular industries.

However, opportunities for growth and transformation are vast, particularly through European initiatives such as the S3 Industrial Modernisation Platform, which enhances cross-regional cooperation in sustainability and industrial innovation.

5.1. Specific sectoral needs in Piedmont region (Italy)

The state of the art in sustainable and (digital) circular product development within the mechanics and mechatronics sector is evolving rapidly, driven by technological innovations and increasing market demand for eco-friendly solutions. Best practices include integrating resource recovery models, where companies focus on reducing waste through recycling, reusing materials, and optimizing energy efficiency. Virtuous enterprises showcase a commitment to sustainability through the development of technologies that monitor energy consumption, reduce carbon footprints, and minimize material waste; prime examples of how circular principles are being applied are the integration of IoT solutions for real-time energy consumption tracking or the innovative use of additive manufacturing to minimize material waste in metal production. However, despite these advancements, there are significant gaps and challenges in fully realizing the potential of circular transformation in the sector, such as internal resistance from customers who are unwilling to absorb the costs of sustainability measures, making it difficult to justify sustainable investments despite their long-term benefits, struggles with sourcing sustainable raw materials, which limits its ability to reduce the environmental impact of its production processes, or overcoming supply chain dependencies that complicate the implementation of sustainable practices across the entire production cycle. These barriers highlight a key issue: the internal challenges in advancing sustainability beyond regulatory compliance, which affects companies' ability to leverage sustainability as a central business driver.

Externally, companies in this sector face regulatory and market uncertainties. Inconsistent sustainability standards, complex regulations, and slow-moving

bureaucratic processes hinder progress, especially when competitors who do not prioritize sustainability can offer lower-priced products. These challenges underscore the need for a harmonized regulatory framework to ensure fair competition and enable businesses to scale sustainable innovations.

To successfully address these challenges, a market readiness assessment is crucial. The mechanics and mechatronics sector in Piedmont is well-positioned to adopt sustainable products, given the region's strong manufacturing base and the growing demand for eco-efficient solutions. However, there is a need for industry collaboration and investment in sustainable supply chains to overcome the identified barriers. These companies must adapt their business models to integrate circular principles, such as resource recovery and waste minimization, into their everyday operations. Furthermore, the sector must address market readiness by promoting the development of green technologies, facilitating knowledge exchange on best practices, and supporting the training of employees to implement sustainable practices across all stages of production.

The key characteristics of the targeted sector in Piedmont reveal a commitment to sustainability, but also significant hurdles in fully realizing circular transformation. These include the need to better integrate circular economy principles into core business strategies, address customer perceptions of the value of sustainability, and overcome supply chain limitations.

PLASTIC AND PACKAGING

The chemical industry today is strongly committed to environmental sustainability. Considered by many to be a sector that produces polluting products, in reality, according to the latest Greenitaly Report, the chemical industry in Italy is the leading industrial sector in terms of the number of companies (60%) investing in new products and technologies with greater energy savings and/or lower environmental impact. An analysis conducted by UnionCamere Piemonte (Union of the Chambers of Commerce in the Piedmont Region) in 2023 has revealed the state of the art of the circular economy in the Region. In particular, two out of three companies are familiar with the principles of the circular economy (66,8% of the total companies interviewed), and among that, chemical and plastic enterprises, as well as the electric and electronic companies,

have greater awareness. The main reasons for companies to apply circular economy principles are:

- Economic;
- To be compliant with more restrictive regulations planned for the near future in order not to lose the opportunity to compete;
- To achieve greater visibility and/or improve corporate image;
- To create new partnerships and opportunities;
- To enter new markets

From the point of view of technology readiness, the mechanical recycling of plastic is a very well-known process and is considered environmentally friendly but with higher costs of investments. Companies tend not to invest and prefer to outsource the technology. Bioplastic and biobased products (also for packaging) have the same performance of "traditional" products and could be easily replaced. The costs, also in this case, are higher: companies need economic support to sustain these types of investments. Moreover, the respondents interviewed outlined the clearness of EU and National laws and regulations, especially in terms of the definition of the “end of waste”.

6. MALOPOLSKA REGION (POLAND) - REGIONAL ANALYSIS



Poland places significant emphasis on the **S3 Strategy (Smart Specialisation Strategy)**, **green transition**, **cleantech transition**, **circular economy**, and **recycling** as key pillars for its sustainable development and economic competitiveness.

Poland's approach is largely shaped by EU directives and regulations, which it then transposes and implements at the national level. Key overarching policies and strategies include:

- Roadmap for Transition Towards a Circular Economy (2019): This document, prepared by the Interdepartmental Circular Economy Group, outlines actions to maximize the value of resources and minimize waste. It identifies priorities in sustainable industrial production, sustainable consumption, bioeconomy, and new business models. It emphasizes innovation, industry-science cooperation, and the development of a secondary raw materials market.
- National Waste Management Plan: This plan sets out objectives and measures for waste prevention, preparation for re-use, recycling, and other recovery methods, aligning with the EU waste hierarchy.
- Energy Policy of Poland until 2040: While traditionally focused on fossil fuels, the updated strategy includes a gradual shift towards renewable energy sources (RES) and nuclear energy, acknowledging the need for a green transition. It sets targets for RES in the energy mix and for greenhouse gas (GHG) emission reductions.
- National Recovery and Resilience Plan (NRRP): Poland's NRRP allocates a significant portion of funds (over 46%) to support the green transition. This includes investments in offshore wind energy, energy-efficient building renovations, green hydrogen technologies, and sustainable mobility.

- Poland's S3 Strategy: This strategy identifies key areas for smart specialization, many of which align with the green transition and circular economy principles. These include Green technologies and capacities, Sustainable agriculture and food, Innovative industry.

Circular Economy and Recycling in Poland gains the momentum in shifting from a linear to circular economy model. Key initiatives and policies include:

- Waste Hierarchy Implementation: Prioritizing waste prevention, re-use, recycling, and finally, disposal.
- Extended Producer Responsibility (EPR): Encouraging producers to take responsibility for their products throughout their lifecycle, including design for recyclability.
- "Circular Economy in Municipalities" Program: A pilot program launched to promote circular economy practices at the local level.
- Polish Circular Hotspot (PCH): An initiative established to support businesses, cities, and the government in the transition to a circular economy by developing strategies and action plans.

Support for Recycling Infrastructure: Investments are needed to improve waste collection, sorting, and recycling capacities.

6.1. Specific sectoral needs in Malopolska region (Poland)

1. Regulatory Pressure and Compliance

- **Plastics and Packaging Regulations:** Poland's strict adherence to EU regulations on plastic waste management, such as the ban on single-use plastics and the introduction of deposit return schemes, poses significant challenges for manufacturers. These regulations increase the complexity of production processes and lead to higher costs associated with compliance.
- **Extended Producer Responsibility (EPR):** Producers in Poland are facing increasing EPR obligations. The responsibility for waste collection, recycling, and reuse of packaging materials can strain manufacturers, especially small and medium-sized enterprises (SMEs), as they must manage these logistics and contribute financially to waste management systems.

2. Cost of Transition to Circular Economy

- **Investment in Green Technologies:** The shift towards a circular economy and sustainable practices requires significant investments in new technologies, equipment, and processes, particularly in plastics and packaging. These investments can be expensive for manufacturers, particularly SMEs that may struggle to access financing or lack the resources to implement such changes.
- **Higher Production Costs:** Green technologies, recycling processes, and sustainable raw materials tend to come at a premium. This can increase production costs in sectors like packaging and construction, making it difficult for companies to maintain profitability while also adopting environmentally friendly practices.

3. Supply Chain and Material Shortages

- **Raw Material Availability:** The availability of sustainable raw materials is still a challenge in Poland. In the plastics sector, manufacturers are struggling to secure adequate supplies of recycled plastics or bio-based materials that meet both environmental standards and quality requirements.
- **Global Supply Chain Disruptions:** Like other European countries, Poland's manufacturing sector has faced disruptions in global supply chains, especially during the COVID-19 pandemic and geopolitical tensions like the war in Ukraine. This has led to delays in obtaining critical materials such as construction steel, plastics, and packaging components.

4. Recycling and Waste Management Challenges

- **Recycling Infrastructure:** While Poland has made strides in improving recycling rates, the infrastructure and technology for recycling in sectors like plastics and packaging are still developing. Efficient waste sorting, processing, and recycling systems are necessary to meet the EU's circular economy goals.
- **Quality of Recycled Materials:** In the plastics and packaging industries, one of the persistent challenges is the inconsistency in the quality of recycled materials. This can make it difficult for manufacturers to incorporate recycled content into their products without compromising product quality.
- **Building Waste Recycling:** In the construction sector, while efforts are being made to reuse building materials, there are still barriers in terms of sorting and

recycling construction waste effectively. The lack of efficient waste processing facilities for construction and demolition debris remains a bottleneck.

5. Technological and Innovation Gaps

- **Lack of Advanced Technologies:** While Poland's manufacturing sector is adopting newer technologies, there are still gaps in the adoption of high-end technologies like automation, AI, and digitalization in industries like construction and packaging. This limits productivity and the ability to quickly adapt to new sustainability standards.
- **Innovation in Construction Materials:** The building and construction sector faces challenges in developing and incorporating innovative, sustainable materials. The availability of affordable green alternatives, like recycled or bio-based materials, is still limited in Poland, hindering efforts to reduce the environmental impact of construction activities.

6. Skilled Labor Shortage

- **Technicians and Engineers:** The manufacturing sectors, particularly those transitioning to more sustainable practices, need skilled workers who are well-versed in green technologies, sustainability practices, and recycling processes. However, there is a shortage of professionals with expertise in these areas, which slows down the pace of transformation.
- **Training Needs:** Manufacturers in sectors like plastics, packaging, and construction need workers with specific skills in new technologies, circular economy processes, and green building techniques. While some training programs are available, there remains a gap in highly specialized education and training focused on sustainability and innovation.

7. Competitive Pressure and Market Dynamics

- **Cost-Competitive International Market:** Polish manufacturers, especially in plastics and packaging, face pressure from countries with lower production costs. Countries outside the EU, where environmental regulations are less stringent, can offer cheaper alternatives, making it harder for Polish companies to compete on price, even if they are more sustainable.
- **Market Demand for Green Products:** While demand for environmentally friendly products is growing, there is still a significant portion of the market in Poland and

beyond that is price-sensitive and not yet fully willing to pay a premium for green or recycled products. This mismatch between market demand and sustainable production capacities can lead to slow adoption.

8. Environmental and Climate Change Pressures

- **Carbon Emission Reduction:** Poland's manufacturing industry is under pressure to reduce carbon emissions as part of EU climate goals. While industries like construction and plastics contribute significantly to emissions, transitioning to low-carbon technologies and processes can be capital-intensive and complex.
- **Sustainability and Carbon Footprints:** In construction, using traditional building materials like cement and steel is carbon intensive. Transitioning to more sustainable alternatives while maintaining cost efficiency and structural integrity presents a major challenge.

9. Public Awareness and Consumer Behaviour

- **Low Consumer Awareness:** There is still a lack of widespread understanding among consumers in Poland regarding the importance of circular economy practices, such as recycling and sustainable construction materials. This impacts market demand for sustainable products and packaging.
- **Behavioural Change:** Encouraging both consumers and businesses to adopt circular economy principles (e.g., reducing waste, reusing materials) is challenging, especially when it requires changes in established habits, such as the way packaging is disposed of or how buildings are constructed and demolished.

7. HUNGARY - REGIONAL ANALYSIS



In Hungary, at the political level, sustainable product development is a top priority. Hungary's S3 strategy encourages the use of biodegradable materials and the enhancement of recycling processes to minimize environmental impact, particularly in the plastics and packaging industries. Hungary invests significantly in R&D, spending 1.4% of its GDP on civil research and development.

The S3 strategy emphasizes innovation, environmental responsibility, and sustainable development across several key sectors, including plastics, packaging, construction, and mechanics. The S3 strategy is aligned with European Union (EU) regulations, making it instrumental in fostering green transition while addressing the specific sector needs and challenges faced by the country. The National Research, Development and Innovation Agency manages nationwide the implementation and monitoring of S3 strategy. Moreover, there is a significant emphasis on research and development for advanced sustainable packaging solutions.

The strategy encourages innovation that minimizes waste and carbon footprints throughout product life cycles, thereby enhancing Hungary’s competitiveness. The strategy further identifies the need for sector-specific initiatives. Key sectors for growth include advanced manufacturing, agriculture, health, and information and communication technology (ICT). In the construction and mechanical sectors, the S3 strategy actively supports the adoption of green technologies and sustainable materials, emphasizing the importance of energy-efficient buildings and innovative machinery designed to minimize environmental impact. However, the country faces several sector-specific needs that must be addressed to realize its sustainability goals. For instance, companies have expressed a strong need for clear strategic guidance and significant financial support as they transition towards sustainable practices. The current landscape reveals a critical requirement for

sector-specific strategies that can provide Small and medium-sized enterprises (SMEs) with the frameworks and resources necessary for meaningful progress. Moreover, the underdeveloped infrastructures for recycling and renewable energy pose significant challenges to the green transition in Hungary. Without adequate support systems for startups and SMEs in green sectors, the country risks falling short of its sustainability objectives. Awareness and education are also paramount in this effort. Increased awareness of sustainability among the civil society, the next generation who become the buyers of the future is crucial. Also, the knowledge of relevant regulations is necessary, especially among small and medium-sized enterprises. A gap exists in knowledge regarding EU directives, which could hinder compliance and progress toward sustainability. Raising awareness and providing education about EU directives will be critical in ensuring compliance and fostering a culture of sustainability across sectors. Another major challenge is the access to finance. While funding opportunities are available, they are often insufficient or challenging for smaller enterprises to access. This limited financial support hinders SMEs' ability to invest in green technologies and commit to sustainable operations, which are necessary for achieving Hungary's broader environmental goals. Moreover, majority of Hungarian SMEs lack the foreign language knowledge and the confidence to enter the international market that hinders their development and experience exchange with economically more developed European companies. Inconsistent and ever-changing regulatory environment causes uncertainty and frustration among SMEs that can lead to inconsistencies, making it difficult to navigate the transition to sustainable practices effectively.

7.1. Specific sectoral needs in Hungary

Hungary’s performance in circular economy indicators reflects certain strengths in societal behaviours, but weaknesses in business operations. The country has a circularity rate of 8.7%, which is below the EU average of 12.8%. Recent efforts to bolster the circular economy culminated in a national strategy published in 2023. This strategy aligns with the 2030 Agenda for Sustainable Development and the ambitions outlined in the European Green Deal, aiming to transition Hungary's economy toward more sustainable practices.

Hungary's mechanics and mechatronics sectors are experiencing notable progress, boosted by cross-border investments and a favourable geographical position within Central Europe.

The Hungarian government promotes research and development initiatives to drive advancements in automation and robotics. Despite the advancements, there is a lag in the pace of transformation toward circular economy practices in this sector compared to plastics and packaging. Continued investment in training and education is required to ensure that the workforce can meet the demands of an evolving market. In the mechanics and mechatronics industries, there is a strong demand for greater Research and Development (R&D) spending to investigate new manufacturing methods that prioritize sustainability. The development of supportive infrastructure (e.g.: renewable energy grids) is needed to leverage Hungary's geographical location by attracting more international investments focusing on sustainable practices. The Hungarian industrial automation market, encompassing mechanics and mechatronics, is projected to grow at a compound annual growth rate (CAGR) of 10.2% from 2024 to 2030. This growth is driven by substantial investments from global automotive manufacturers such as Mercedes, BMW, Audi, and CATL, leading to increased demand for automation technologies in manufacturing that could facilitate the needed support.

The plastics industry in Hungary faces considerable challenges, primarily due to rising energy costs that have led to increased production expenses. Therefore, financial incentives are needed to support companies in adopting energy-efficient technologies and exploring alternative energy sources. Hungarian companies are struggling to maintain profitability and long-term viability; thus, governmental support is essential for their survival. Transitioning to sustainable practices is essential, but companies need incentives and regulatory support to innovate effectively. Although some firms are exploring energy-efficient technologies and alternative energy sources, the expansion of single-use plastics underscores the critical need for international agreements. Hungary has implemented several regulations to address environmental concerns associated with plastics although there is still a strong need for more improvement i.e.: Environmental Product Fee (since 1995), Extended Producer Responsibility (EPR) (since 2023), Single-Use Plastics Ban, Green Public Procurement (GPP). Furthermore, the industry requires a shift in focus from recycling to reducing production of single-use plastics. There is an urgent need for comprehensive regulations that mandate reductions in plastic production and encourage innovation in biodegradable materials. It is essential to establish international partnering cooperation to establish recycling frameworks, as current recycling rates remain

insufficient, with only 10% of global plastic waste being recycled. The Hungarian plastic industry comprised approximately 1,684 enterprises in 2022 achieving a turnover of €5.1 billion in the same year. Additionally, companies need access to the latest market developments and energy policies to monitor changes affecting their operations. A strong professional cooperation between stakeholders, policymakers and civil society is important to facilitate a cultural shift around plastic usage and promote a more sustainable mindset.

The biggest challenges that the Hungarian construction industry faces is the declining demand and high inflation. Labor migration due to unfavourable economic situation and the low quality of vocational training are strengthening the shortage of specialists resulting in a supply-driven market. In June 2024, production volume in construction fell by 6.4%, signalling systemic issues. The National Federation of Hungarian Building Contractors has advocated for stimulating demand through improved financing conditions and public investments. Encouraging public-private partnerships and supporting local product usage can help stabilize the market. Increasing recycling rates of construction materials, aiming for a minimum 70% reuse and recycling of construction waste, remains a fundamental goal in the National Waste Management Plan. In the building and construction industry, a pressing need is to stimulate demand for sustainable practices and enhance financing conditions for eco-friendly projects. The sector is struggling with high inflation rates and a decline in municipal contracts, necessitating increased public investment and the creation of public-private partnerships to revitalize market stability. There is also a critical requirement for improved recycling and reuse rates in construction materials, with the aim of achieving a minimum of 70% recycling of construction and demolition waste. Establishing new recycling centres and implementing a tracking and monitoring system for waste materials will significantly enhance the sector's circularity. Moreover, the industry requires greater emphasis on the use of local products to reduce dependency on imports. Initiatives that promote the integration of sustainable building materials - alongside comprehensive eco-design guidelines - will facilitate the construction of energy-efficient infrastructure and contribute to minimizing environmental impacts. Finally, enhancing workforce skills through targeted training programs in sustainable construction practices is crucial to fostering a knowledgeable labour force capable of implementing these new approaches effectively.

In the packaging industry of Hungary, there is a growing emphasis on sustainability driven by consumer demand. Companies are introducing biodegradable and recyclable materials while adapting to the evolving local and EU regulations. Innovative packaging solutions are needed to ensure safe shipping in the recently fast-growing online commerce and enhance customer experiences. Cutting-edge technologies such as automation, IoT-enabled packaging, and digital printing are becoming more common that helps companies meeting increasing consumer demands for sustainability and the international requirements while improving operational efficiency. An immediate need is the development of sustainable recyclable and biodegradable packaging materials. In the packaging induction the adaptation of new materials is a key to competitiveness. Another critical need is for clear and consistent regulatory guidelines concerning packaging waste. Businesses require support in navigating EU regulations while simultaneously managing local compliance requirements. Educational initiatives aimed at both businesses and consumers can enhance awareness and acceptance of new packaging solutions. There is a strong need for collaboration between industry players to share best practices and innovations, which can foster a more significant collective shift toward sustainability in packaging processes.

As Hungary advances its national strategy aligned with the EU Circular Economy Action Plan, it must prioritize building the necessary infrastructures, improving access to funding, and fostering cooperation among businesses, governmental agencies, and educational institutions. The road to transformation is indeed challenging, but with a committed approach, strong investment in education and technology, and a supportive policy environment, Hungary can successfully navigate the transition and secure a sustainable future for its key sectors.

8. SLOVAKIA – REGIONAL ANALYSIS

Sustainable production and the circular economy are key pillars of the Slovak Republic's transition to a greener and more competitive economy. This chapter provides a review of existing national documents and policies that define Slovakia's strategic direction in these areas, considering the European framework and the current needs of the industrial (business) sector.



Smart Specialization of the Slovak Republic 2021-2027 (hereinafter referred to as "SK RIS3 2021+") represents a strategic document defining goals, policies and measures in the field of research, development and innovation. At the end of 2024, the final version of the update of the SK RIS3 2021+ smart specialization strategy was presented. From the point of view of the objective orientation of the CURIOST project, it is important to highlight the following:

Domain 1: Innovative Industry for the 21st Century

- Domain Target – i) to support innovative solutions and development in the field of advanced technologies and materials applicable in industry and environmental protection; ii) increase the energy efficiency of industry, reduce environmental impacts, including by further improving the energy mix towards carbon-free and low-carbon energy; iii) to promote the circular economy, local production, resource efficiency and innovations that increase the stability and security of the country's economy.
- Priority axis 1.2 – Processing of raw materials and semi-finished products – a significant shortcoming for Slovakia's ability to increase the share of waste processed and the use of secondary raw materials is the absence of recycling capacities that would enable the use of secondary raw materials, especially in areas such as plastics, metals and

other materials, which represent a significant share of total waste in Slovakia (wood, paper and cardboard, glass, textiles, tires, construction waste, etc.). According to the EU's objectives and initiatives, the share of secondary raw materials in the economy is expected to increase in the coming years. For Slovakia, this means the need for further development and innovation in the field of recycling and the use of secondary raw materials.

Challenges of sustainable production in Slovakia: tools, demand and education

The transition to sustainable production and the circular economy (CE) is a complex process that requires not only technological innovations and legislative frameworks, but also a change in social and economic behaviour. Although the Slovak Republic has adopted several strategic documents that support the development of circular models and green innovations, practice shows that several key conditions for successful implementation are still missing. The most fundamental challenges include insufficient financial and methodological tools for evaluating the sustainability of products, low demand for ecological and recycled products, and the need for systematic education in the field of CE.

1. Lack of financial and methodological tools for sustainability assessment; One of the main obstacles to effective support of sustainable production in Slovakia is the lack of availability of tools that would allow companies to objectively assess the environmental impacts of their products throughout their life cycle – from the extraction of raw materials to their disposal or recycling. At the same time, there is a lack of a uniform national framework or standardized guidelines that would provide companies with guidance on how to approach the assessment of the environmental performance of their products. This leads to low transparency in the market.
2. Low demand for recycled and eco-friendly products; This trend is determined by several factors. First, it is the low public awareness of the benefits of the CE and the environmental impacts of normal consumption. Consumers often do not have enough information to distinguish a truly sustainable product from one that only uses "green" marketing. At the same time, perceptive price sensitivity, typical especially for the Slovak market, also plays a role – organic products are often more expensive, as they do not benefit from the same economic benefits as mass-

produced alternatives. Without significant incentives or policies to promote such products, for example in the form of public procurement or VAT reductions on sustainable products, demand for them is limited. The underdeveloped market for recycled materials, together with legal and technical barriers to their use, means that recycled content in products continues to be the exception, not the rule.

3. The need for education and awareness of CE; Slovakia has long suffered from insufficient systemic education in the field of environmental sustainability. Education is equally important for entrepreneurs, local governments and public institutions, which can be important actors of change.

8.1. Specific sectoral needs in Slovakia

In Slovakia is attention on two sectors – plastics and packaging. The Slovak Republic has made some progress in the circular economy in recent years, but it still faces a number of financial and non-financial challenges.

PLASTICS: in 2022, Slovakia produced just under 27 kg of plastic waste per capita and ranked eighth in the recycling ranking with 15.93 kg, just above the European average. A positive factor is that the proportion of recycled plastic waste is gradually increasing. However, the amount of waste itself is still growing while recycling has increased by 5.6 percent compared to 2010, the volume of plastic waste produced from packaging has increased by a third. The main problem remains the quality and price of recycled plastics compared to newly produced materials. The situation is also complicated by the fact that there are many types of plastics. Their processing is then much more difficult, more expensive, and the final product does not have the quality that would be expected. Between 2023 and 2025, Slovakia has made significant progress in plastic management, mainly through legislative measures and initiatives aimed at increasing recycling and reducing plastic waste. Since January 2022, Slovakia has introduced a deposit system for PET bottles and cans, which has led to a significant increase in their return. According to OECD data, the return rate of this packaging increased from 70% in 2022 to 92% in 2023, prematurely meeting the EU's target of achieving a 90% return by 2029. In accordance with the EU's Single-Use Plastics Directive (SUP), Slovakia has taken several measures: from 3rd of June 2024, it is prohibited to place beverage packaging on the market without firmly attached plastic lids; From 1st of January 2025, new PET bottles must contain a minimum

of 25% recycled plastic, increasing to 30% from 2030. In October 2024, the Ministry of the Environment of the Slovak Republic announced a call from the Slovakia Programme to support the preparation of waste for reuse and recycling, with an allocation of almost €30 million. The aim is to build new recycling capacities for biodegradable and construction waste, which will contribute to reducing the amount of plastic waste ending up in landfills. Eligible applicants are persons authorized to do business in the field of waste management, as well as municipalities and cities, self-governing regions, associations of natural or legal persons, but also non-profit organizations providing generally beneficial services. Despite the financial support, SMEs faced several challenges in the field of plastics recycling. In 2023, there was a significant slump in the recycled plastics market, which led to a reduction in production and a reduction in work shifts in some companies. The situation began to improve at the beginning of 2024 in anticipation of the mandatory blending of recycled material into PET bottles from 2025. Increasing imports of recycled plastics are also a particular concern for European plastics processors, which threatens the EU recycling industry and can increase the overall carbon footprint as an unintended consequence. The price volatility of the primary raw material PET, which fluctuates around the level of EUR 1,150 per tonne, but in the past fell to EUR 650 and in 2022 was at EUR 1,800, also has a significant impact on the economy of processors.

PACKAGING: in the period from 2023 to 2025, the Slovak packaging industry is undergoing significant transformations because of adapting to new environmental regulations and growing sustainability requirements. The transition to a circular economy brings significant challenges, especially when it comes to redesigning packaging to meet new standards of recyclability and the introduction of more sustainable materials. The use of more sustainable packaging material and systems is already a heavy financial burden, especially for smaller companies – companies need to find the means to develop new products, modify production lines and implement effective recycling systems. A positive trend is the growing recycling rate of packaging waste in Slovakia. In 2023, the recycling rate for municipal waste reached 51.3%, with packaging waste achieving a success rate of 72%. This increase is the result of expanded producer responsibility and improvements in collection and recycling infrastructure. Small and medium-sized enterprises in the packaging industry in Slovakia are currently facing several challenges, which result from the changing regulatory framework, growing environmental requirements and changing

consumer behaviour. Given their size, limited capacities and financial capabilities, SMEs are particularly vulnerable to these changes.

- One of the biggest challenges is adapting to stricter European and national regulations, which result mainly from the Single-Use Plastics Directive and the upcoming EU Packaging and Packaging Waste Regulation (PPWR). Businesses are expected to use packaging that is lighter, recyclable, or made from renewable or compostable materials. However, SMEs often do not have sufficient capacity to develop new types of packaging, test their functionality or certify them to the required standards. (Solution: SMEs often rely on external cooperation – either with larger companies, packaging suppliers, research institutions or clusters such as the Slovak Plastics Cluster or the Food Chamber of Slovakia. It is such partnerships that enable the sharing of know-how and access to innovation.)
- Switching to eco-friendly materials, changing the design of packaging or investing in new production technologies represent a significant financial burden. SMEs, which often operate with lower margins and have limited access to credit, may find it difficult to implement these changes without external support. (Solution: SMEs are trying to optimise packaging design to meet environmental requirements, but at the same time not to increase production costs. There is also a growing interest in minimalist, resealable or reusable packaging that combines functionality with an environmental aspect.)
- SMEs do not have enough storage space for new types of packaging materials, face supply chain disruptions (especially for bioplastics and specialty films) or do not have sufficiently flexible production lines to process new types of packaging. (Solution: Flexibility is becoming a key trend – SMEs are investing in smaller, modular lines or looking for hybrid solutions that allow for transitions between different packaging. At the same time, cooperation networks are being created, where several SMEs share logistics or production capacities.)

9. PRIORITY INTERVENTION AREAS

Priority intervention areas assume that interventions and actions proposed will lead to stronger impact in transformation to adopting (digital) circular economy practices and sustainable product development. Priority intervention areas can be targeting the

region/country, policy makers or be sector specific, which every partner chose freely and accordingly to their analysis and specific needs. In addition, there are also cross- sectoral actions proposed for stronger impact across all sectors simultaneously. For this analysis, the most influential and frequently used priority intervention areas by the project partners were summarized for all project partners and partner countries. In total, eight highlighted priority intervention areas, accompanied by catalogue of concrete actions as an annex proposed by project partners for their respective region/ country or specific sector are listed below.

Priority intervention areas listed:

1. Support for training qualified personnel and SMEs in sustainable product development, business models and circular product design

An important and often emphasized priority area among project partners, detected that SMEs and medium-sized enterprises lack knowledge and skills to fully integrate sustainable and circular practices into their business models. Targeted training programs empower companies, while building competences essential for overcoming internal barriers. This intervention area aims to increase awareness among SMEs and competences through targeted training programs, peer learning and sector- specific guidance tools. Lacking the expertise in circular design and digital tools usage (Iot), faulting waste reduction strategies are hindering the circular transition. Therefore, the improvement of practical knowledge can facilitate compliance with EU sustainability goals and accelerate transformation.

2. Engagement in European/regionally funded projects, facilitate the access for SMEs to EU funding to boost investments for circular transformation

Critical funding gap persists, particularly for SMEs in essential sectors like construction, plastics and manufacturing which is limiting the scalability of pilot projects. Providing information and guidance on available funding opportunities, update members on relevant national, European and regional funding programs, supporting green transition and circular economy initiatives is becoming essential for successful transformation. Accompanied to it, support in preparing funding applications and proposals for grants is highly relevant. The goal is to connect companies with potential investors interested in

circular economy solutions as well as explore opportunities for establishing regional green financing mechanisms in collaboration with local financial institutions. Creation of AI based tool would be beneficial for usage of funding programmes with focus to simplify the understanding of EU directives and regulations, as well as to facilitate access to funding programmes for SMEs through improving compliance and operational efficiency.

3. Cross regional cooperation platforms – collaborative platforms and industry networks for knowledge sharing and best practices exchange

Cross-regional cooperation platforms are vital for transformation to a circular economy, as they address fragmented efforts and promote collaboration among academia, industry, and public authorities. By fostering partnerships through virtual hubs, cross-border initiatives, and digital tools, these platforms can significantly enhance knowledge sharing, infrastructure development, and policy alignment. This collaborative approach will reduce regional disparities and make Central Europe a leader in circular transformation. Organizing awareness-raising campaigns, information days, webinars, and other educational initiatives targeted at the public and the future generation can effectively boost demand for sustainable goods. Compiling successful circular economy initiatives and technologies, connecting to research institutions in targeted sectors, create matchmaking events, creating joint projects are just some of the ideas through which collaboration can be used for endorsing circular transformation.

4. Harmonization and legislative clarifications and standardization of product sustainability assessment methodologies

Too many regulations create a substantial compliance burden on domestic businesses, as they face challenges due to the absence of clear guidance and support tailored to local contexts. Harmonisation of sustainability policy framework, encompassing all regulations and directives related to the topic of circular economy is important for companies because it facilitates regulatory compliance, access to finance and enhances competitive advantage. One step forward was introduced by European Commission recently with presenting Omnibus package for reducing administrative burdens on the companies falling under scope for sustainability reporting. Further on, introduction and standardization of product sustainability assessment methodologies is encompassing development of national

methodologies for life cycle assessment of plastics and packaging in accordance with European standards, introduction of eco-labels to support informed customer decisions and standardization of eco-design requirements, as well as hosting information webinars on digital product passport (DPP), as part of Eco-design regulation.

5. Market support and strengthening the innovation capacities of companies

Market support for recycled and eco-friendly products is gaining attention in the circular transformation. Promotion of green public procurement, defining minimum environmental criteria for procurement, creating stable market incentives for recycled materials, raising awareness towards consumers while focusing on benefits and safety of recycled and environmentally friendly products are just some of measures used for market regulation of circular products. Creating platforms for companies to present their innovative offerings to potential customers and partners, as well as including relevant stakeholders in the process are important future steps. Since there are companies already participating and developing circular solutions, such as recycled construction materials, they can face challenges in bringing them to market. Companies need support to move beyond pilot or prototype stage, which will enable transition from concept to market-ready circular products and services by connecting innovators with funding, infrastructure and end users.

6. Raising awareness and education, advocacy activities and providing expertise

Improving access to information about available support and funding opportunities is a way to start with education on circular transformation. By conducting awareness campaigns, broader business community and the public are being informed about the benefits of the circular economy. Clusters, platforms, innovation parks should represent the interests of companies in discussions with regional and national policymakers regarding regulations and support mechanisms for the circular economy. Such organisations have enough influence and knowledge to act as facilitators and knowledge hubs and can contribute to the adoption of sustainable solutions and circular practices. This circular transformation should be accompanied with education activities in schools

and universities, offering deeper understanding of the links between the economy, industry and natural resources. Education activities should have systematic support from the state and educational institutions. Awareness raising campaigns for circular economy, including campaigns motivating consumers, promoting recycling, reuse and supporting sustainable productions should be more often and target broader public.

7. Focus on supply chain sustainability and raw materials sourcing

One of the primary barriers faced by companies is the difficulty in sourcing sustainable raw materials. This challenge is critical for facilitating the transition towards circular business models, as access to sustainable materials is fundamental for reducing the environmental impact of manufacturing processes. Companies need support in developing sustainable supply chains, including sourcing of recycled or bio-based raw materials and fostering partnerships with suppliers who can meet these sustainability requirements. The region's strong industrial base offers opportunities to integrate regional circular supply chains, reducing reliance on virgin materials and supporting the resource recovery model. Strengthening the sustainable raw material infrastructure would significantly boost market readiness and accelerate the adoption of circular principles in the sector. Targeting businesses and consumers with education on usage of bio-based plastics and recycled plastics and dissemination of success stories on circular construction with recycled building materials should be implemented as well.

8. Integration of digital tools and AI to endorse the transformation to circular economy

Integration of AI or 3D tools is especially relevant in the sector of mechanics and mechatronics with focus on 3D printing, artificial intelligence and reverse logistics. Transformation to circular economy can be achieved by stronger usage of digital tools in the mechatronics sector. Other digital solutions are also available for different sectors, such as implementing AI Analytics, implementing systems to track recycling, using blockchain, using digital tools to extend product lifecycles and reduce waste, as well as offering digital solutions such as digital product pass and education about it.

10. CONCLUSION

To conclude, project partners defined the status and difficulties in their respective project regions and targeted four sectors, which hinder the successful transformation to circular economy and sustainable product development. That is why they pointed out 8 priority intervention areas, that can make more impact and stronger market change in the transformation to circular economy. Concrete actions that will be chosen and developed in detail in CURIOST Action Plan, are listed in the document “Catalogue of concrete actions” and serve as a foundation for future policy recommendations. Emphasize is on the concrete actions of collaborations, raising awareness about circular economy, training the SMEs and small midcaps on sustainable production and integration of digital solutions in transformation to circular economy and sustainable product development. Making policy easier and understandable to SMEs and small midcaps increases the accessibility of European, national and regional funds which encourages innovations and pilot projects.

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