

Transnational mapping of status quo in machine industry

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Introduction

Let's start with a definition of the circular economy according to Zero Waste Europe (<https://zerowasteurope.eu/about/about-zero-waste/>):

“The circular economy is a model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible; and tackling the presence of hazardous chemicals along the whole value chain. In this way, the lifecycle of products is extended in a toxic-free environment. In practice, it implies designing safe and sustainable products, and right systems, to reduce waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used over and over again within non-toxic material cycles, thereby creating further value.”

Short introduction to the PLAN-C project

Moving PLastics and mAchine iNdustry towards Circularity (PLAN-C) is an international project focusing on the Danube region. The project consortium consists of 14 project partners from 9 (AT, BiH, CZ, DE, HU, MD, RO, RS, SK) countries whose regions are part of the Danube Region.

As the project name suggests, the main objective of the project is to support the transformation of the plastics value chain in the Danube Region towards a circular economy through transnational cooperation. In addition to the core consortium of project partners, a number of other actors are involved, ranging from associated strategic partners to stakeholders representing plastics processors and manufacturers of plastics processing machinery.

The joint effort is to develop a vision of a transformed plastics value chain designed for the circular economy and to demonstrate the benefits of plastics reuse/recycling and maintenance, redistribution, refurbishment/remanufacturing and recycling of machinery. The final Transnational Action Plan for anchoring the circular economy in a holistic plastics value chain addresses SMEs, large enterprises, public sector organisations, sector agencies and public authorities.

Objective and scope of the transnational mapping of status quo in machine industry

The transnational mapping of status quo is an evaluation of the regional mapping of the current situation in the field of plastic processing machinery and its sustainability in the Danube region. The analysis of the current state includes the entire value chain of the plastics processing machinery, starting with the *material sourcing, product designs, materials processing and energy savings, technological waste management*, and ending with

end-of-life and *collection of used machine parts and their reintegration, remanufacturing, refurbishment or recycling.*

The scope of the analysis of current status and best practices/failures in the dimensions of *policy and strategy/business support, technology/knowledge and business models/practices* is consistent with the project design and declared results D.2.1.2 to D.2.1.4.

Austria

Policies and business support

Policy

The Austrian partners very appropriately highlighted the extensive EU legislation that member countries are obliged to implement in their national legislation. European legislation is complemented by national and regional policies, particularly in the area of waste management.

- Generic level
 - EU Machinery and repealing Directive EU 2023/1230 (It will repeal the existing directive 2006/42/EC from 2027)
 - ESPR - Ecodesign for Sustainable Products Regulation (EU 2024/1781)
 - ISO standards for Environmental management – Life cycle assessment (ISO 14040, 14044)
- Material sourcing
 - The Green Deal Industrial Plan entitled for the Net-Zero Age (for energy adoption of the REPowerEU plan)
 - European Critical Raw Materials Act (sustainable supply of raw materials)
 - EU Supply Chain Act (Corporate Sustainability Due Diligence Directive CS3D)
- Processing technologies & energy savings
 - In addition to the ESPR, it also includes Corporate Sustainability Reporting Directive (CSRD)
- Collection of used machine & reintegration/refurbishment/recycling
 - Waste electrical and electronic equipment (WEEE, 2012/19/EU)
- Technological waste management
 - Waste management law AWG
 - Packaging regulation VVO
 - Environmental Promotion Act – UFG (Federal Act on the Promotion of Measures in the Areas of Water Management, the Environment, Remediation of Contaminated Sites, Land Recycling, Biodiversity and the Circular Economy and on the Protection of the Environment Abroad as well as on the Austrian JI/CDM Programme for Climate Protection)

National/regional strategic documents

Also, in the area of strategic documents, the strategies that have been adopted in the EU, such as Ecodesign and Energy Labelling Working plan 2022–2024 or United Nation's activity Agenda 2030 for Sustainable Development.

- Generic level
 - EcoDesign and Energy Labelling Working plan 2022 – 2024 (as a part of the European Green Deal, which aims to achieve climate neutrality by 2050)
 - Agenda 2030/SDGs (17 goals for sustainable future)
 - Austrian FTI Strategy (Research, technology and innovation strategy, in particular in the field of circular economy and production technologies)
 - Austrian Recovery and Resilience Plan 2020-2026 (funding for applied research in the field of circular economy)
- Material sourcing & Processing technologies & General level
 - #upperVISION2030 – Upper Austrian Economic Strategy with the subtopic: Efficient and sustainable industry and manufacturing
- Collection of used machine & reintegration/refurbishment/recycling
 - Austrian circular economy strategy (modernisation of machines for producing, sorting and recycling plastics is expected in the area of „Plastics and Packaging“)
- Technological waste management
 - Zero Waste Europe (a network of European NGOs focusing on sustainable economy)
 - Smart Klima City Strategy Wien: Chapter 4.5 Zero Waste & Circular Economy (Generic level – local/regional strategic document)

Funding schemes and further business support measures

Funding schemes

- Generic level
 - FFG – Austrian Research Promotion Agency
 - Call “Circular economy and production technologies 2024”
 - Innovation voucher and Impact Innovation Call (support for research and innovation activities for SMEs in Austria)
 - Small scale project or regular project
- Collection of used machine parts and their reintegration, refurbishment and recycling
 - Repair bonus part of the Austrian Recovery and Resilience Plan 2020-2026 (supports repair of electronical or electrical devices)

Business support organizations – offer several services and measures

- Generic level
 - Business Upper Austria with its Mechatronics Cluster, Cleantech Cluster and Plastics Cluster and its initiative “Circular Region Upper Austria”
- Technological waste management
 - Altstoff Recycling Austria GmbH (ARA) – material flow management

Technology and knowledge providers

Among the Austrian technology and knowledge providers, two clusters – *Mechatronic cluster* and *Green Tech Valley Cluster* – are mentioned as the most important. They provide support at a generic level, in the field of material resources and the reintegration, refurbishment and recycling of production facilities and their parts.

- Mechatronic cluster – network for companies working in the fields of mechanical engineering and plant construction
- Green Tech Valley Cluster - technology-hotspot for climate protection and circular economy
- Generic level
 - Circular Economy Forum Austria (platform for the promotion of the circular economy – development of knowledge, ideas and implementation between business, policy, science and research and design.)
 - Circular Futures (platform for the circular economy - building the policy and legal framework for the transition to a circular economy)
 - Open4innovation (the platform for results of publicly funded research and technological development)
 - University of applied science FH BFI Vienna (Certificate Program Circular Economy & Innovation)
- Processing technologies including energy savings
 - Energy Institute at Johannes Kepler University Linz (R&D projects in development of energy system with positive impact on living, economic and environment)
 - TU Wien Academy for Continuing Education (courses in "Sustainability and Energy")
- Technological waste management
 - Montan Universität Leoben (waste as a resource without uncontrolled release of contaminants)

Business models and practices

Role model companies

- Processing technologies including energy savings
 - EREMA Engineering Recycling Maschinen und Anlagen Ges.m.b.H.
 - ENGEL AUSTRIA GmbH
 - Starlinger & Co Gesellschaft m.b.H.
 - Binder+Co AG
- Technological waste management
 - ATM Recycling systems GmbH
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Ziegler Maschinenwelt GmbH
 - P.M.T. Analgenbau GmbH
 - Noebauer Retrofit GmbH

Industrial groupings and networks

Machinery companies focused on sustainability and circular economies are members of a number of networks, platforms and clusters such as the aforementioned Mechatronic cluster, Green Tech Valley Cluster or platforms Circular Economy Forum Austria and Circular Futures.

- VDMA Austria (the association representing economic, technical and scientific interests of machinery and equipment manufacturing industry in Germany and Europe)
- Metaltechnology Austria (the national representation of mechanical and plant engineering, steel construction and metalware production enterprises)

Conclusion

Austria is well ahead in the circular economy for the Danube region's engineering industry, both in terms of policy-making and industry willingness. Although they see challenges in the need to change the mindset of society and to increase incentives for the necessary initial investments of companies in the transition to a circular economy, they are meeting these challenges very successfully.

Bosnia and Herzegovina

Policies and business support

Policy

In addition to legislation on environmental protection or waste management, Bosnia and Herzegovina have identified two key points towards a circular economy. These are platform *Green Perspective - Transition to a Circular Economy and Efficient Waste Management on Bosnia and Herzegovina's European Path* and Document *White paper on circular economy in Bosnia and Herzegovina*, which contribute to raising awareness of the need to move towards a circular economy. As an EU candidate country, it implements EU legislation in national policies.

- Generic level
 - Green Perspective – Transition to a Circular Economy and Efficient Waste Management on Bosnia and Herzegovina's European Path – platform for alignment of national and EU circular economy policies
 - White paper on circular economy in Bosnia and Herzegovina – document provides a comprehensive analysis of the state, challenges, and opportunities for implementing circular economy principles
 - Law on Environmental Protection
 - Regulation on Waste Categories with Lists
 - Chemicals and waste in the 2030 Programme
- Technological waste management & Collection of used machine parts and their reintegration/ refurbishment/recycling
 - Directive 2008/98/EC on waste
 - Waste Management Law
 - Regulation on the management of waste from electrical and electronic products

National/regional strategic documents

National and regional strategies build on transnational plans with a pan-European scope.

- Generic level
 - The European Green Deal
 - Circular Economy Action Plan
 - Zero pollution action plan
 - Federal Environmental Protection Strategy 2022–2032 (strategy aligned with EU legislation and focuses on enhancing environmental sustainability)
- Technological waste management & Collection of used machine parts and their reintegration/ refurbishment/recycling
 - Cantonal Waste Management Plan for Tuzla Canton

Funding schemes and further business support measures

Funding schemes

- Generic level
 - Environmental Protection Fund of the Federation of Bosnia and Herzegovina
 - 2021-2025 United Nations Sustainable Development Cooperation Framework (UNSDCF) for Bosnia and Herzegovina and projects under the programme
- Processing technologies including energy savings
 - Energy Efficiency Project for Bosnia and Herzegovina – BEEP (concerning to energy efficiency of public buildings)
 - Regional Energy Efficiency Project for Bosnia and Herzegovina) – REEP (implementing regulations for eco-design and energy labeling)
 - EU4Green - Supporting the Implementation of the Green Agenda for the Western Balkans (improving awareness and communication on the Green Agenda)

Business support measures

- Circular economy in waste management as a resource (this activity is part of the project Green Refreshments: Sustainable Waste Management and the Role of Municipal Companies in the Circular Economy - Una-Sana Canton)
- Introduction of Waste Management Systems for Specific Waste Streams in Two Cantons in Bosnia and Herzegovina" (project offers a sustainable solution for the disposal of specific waste streams, connected with company ALBA Zenica)
- Training - Circular economy in industry (programme for SME learns the basic principles of the circular economy)

Technologies and knowledge providers

- Generic level
 - Centre for energy, climate, environment, economy and consulting d.o.o. Sarajevo (expert association working in the field of energy, energy efficiency, renewable energy sources, environmental protection and climate change)
 - Centre for the Environment Banja Luka (non-profit association enhancing public awareness about environment)
 - Centre for Ecology and Energy Tuzla (non-profit association enhancing public awareness about environment)

Business models and practices

Role model companies

In terms of technology providers and business models, there is a strong focus on metal recycling companies. Around a dozen companies cover the material sourcing area including recycled metal materials, some also focusing on dismantling used equipment.

- Material sourcing, processing technologies, collection of used machine parts
- Nital d.o.o. Zenica (design, engineering and installation of industrial equipment)
- Alat d.o.o. Konjic (tools for metal processing)
- Ferrum Transporti d.o.o. (recycling of metals and hazardous waste)
- MZ Company d.o.o. (dismantling old plants and machines, recycling of metal waste)
- Feroprom d.o.o. Mostar (purchasing and recycling of iron)
- C.I.B.O.S. d.o.o. (metal waste recycling)
- Aida Commerce d.o.o. (complex waste management)
- Trgosirovina d.d. (collection and treatment of metal and non-metal scrap)
- ZEOS eko-sistem d.o.o. (electrical and electronic waste management system operator)
- Kim Tec Eko d.o.o. (electrical and electronic waste management system operator)

Industrial groupings and networks

- Eko HuB Tuzla (project focused on legislative aligning, circular economy initiatives co-financing programs and education)
- The Arhus Centers Network for the Green Agenda and Environmental Protection
- Eko BiH (an informal network of organisations, groups and individuals focused on the environment)
- Nature Protection Network in Bosnia and Herzegovina (preservation of biodiversity in the region of Zenica-Doboj Canton)

Conclusion

The main approach to the principles of the circular economy in Bosnia and Herzegovina is to rebuild and refurbish older equipment or to use discarded machinery as a resource. Therefore, the establishment of centres for the reintegration, refurbishment and recycling of used machine parts can be crucial for the promotion of the circular economy. In view of the need to raise awareness of the benefits of the circular economy, educational initiatives are a possible solution. Funding support for investment in upgrading technology and infrastructure is also essential. Lack of incentives hinders a faster transition to a circular economy.

Czech Republic

Policies and business support

Policy

National legislation in the Czech Republic implements EU policy and strategy. In the field of environmental management, companies in the Czech Republic are also following the international ISO standards of the 14000 series.

- Generic level
 - Directive 2006/42/EC on machinery (to be replaced by Regulation (EU) 2023/1230 from 2027)
 - Implementation of Directive 2006/42/EC into Czech legislation: Act 22/1997 Coll., on technical requirements for products and Implementing Regulation NV 176/2008 Coll., on technical requirements for machinery
 - ISO 14001 Environmental management systems
 - Directive (EU) 2022/2464, as regards corporate sustainability reporting (CSRD)
- Processing technologies & energy savings
 - ISO 14006 Environmental management systems – Guidelines for incorporating ecodesign
 - Regulation (EU) 2024/... of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for sustainable products/first reading on 23 April 2024
- Technological waste management
 - Act 541/2020 Coll., on waste
 - Decree No. 273/2021 Coll. on details of waste management
 - Decree on Waste Catalogue and Assessment of Waste Properties (Waste Catalogue) 8/2021 Coll.
 - Act No. 350/2011 Coll., the Act on Chemical Substances and Chemical Mixtures (Chemical Act)
 - Act No. 201/2012 Coll., on air protection
- Collection of used machine & reintegration/refurbishment/recycling
 - Waste electrical and electronic equipment (WEEE) is regulated by Act No. 542/2020 Coll., on end-of-life products and Decree No. 16/2022 Coll., on details of the management of certain end-of-life products

National/regional strategic documents

- Generic level
 - Circular Czech Republic 2040 (strategic framework for transforming the Czech Republic into a circular economy by 2040)
 - Agenda 2030 (Czech Republic 2030)

- The Research and Innovation Strategy for Smart Specialization (RIS 3)
- Material sourcing & Processing technologies & General level
 - Action Plan to support increasing self-sufficiency of the Czech Republic in raw material resources by substituting secondary raw materials for primary resources
- Technological waste management
 - Government Regulation on the Waste Management Plan of the Czech Republic for the period 2015-2024 352/2014 Coll.

Funding schemes and further business support measures

Funding schemes

- Generic level
 - OP TAK Operational Programme Technologies and Applications for Competitiveness 2021–2027
 - increases the added value and productivity of SMEs,
 - supports the development of new innovative companies and key skills
 - facilitates a smart transition to a sustainable and digital economy
 - supports SMEs, but also some large enterprises
 - OPŽP (en. OPE) Operational Programme Environment
 - protects and ensures a quality environment for the Czech population
 - minimises the negative impacts of human activity on the environment and climate
 - contributes to solving environmental and climate problems at European and global level

Business support organizations

- Generic level
 - The State Environmental Fund of the Czech Republic (mediating investments in the protection and improvement of the environment in the Czech Republic)
 - Business and Innovation Agency (administers grants from EU structural funds for business development in the Czech Republic)
 - Technology Agency of the Czech Republic (redistribution of financial support from the national budget)
 - Business and Investment Development Agency CzechInvest

Technology and knowledge providers

- Generic level
 - Institute of Circular Economy (INCIEN, non-governmental, non-profit organization that promotes circular economy, provides consultations, make research)
 - Confederation of Industry of the Czech Republic (the independent, not-for-profit organisation that speaks for companies – employers)
 - Czech Plastics Technology Platform PLASTY (CTPP acts as a platform for the exchange of views and experiences about the development of the plastics and related processing industry)
 - Czech Technological Platform for Sustainable Chemistry (SUZCHEM CZ supports the activities and initiatives of organisations working for the development of chemistry and the chemical industry)
 - National Innovation Platform I. Advanced machinery and technology (this platform develops advanced materials, technologies and systems and also focuses on digitalization and automation of production technologies, the application sectors are: engineering and mechatronics, energy, metallurgy and industrial chemistry)
 - The Technology Platform of Engineering Production Technology V (the cluster formulates and defines a long-term research strategy that builds on subsequent implementation into specific R&D projects in the field of machining and forming machines; ongoing project includes the Action Plan for Digital and Green Transformation)
- Processing technologies including energy savings
 - Association of Engineering Technology (the association supports innovative activities in the field of machine tools and forming machines and promotes interests of its members in dialogue with the state administration)
 - Czech Machinery Cluster (it is the association of organizations engaged in engineering and related industry branches, it connects them with their suppliers and institutions oriented on science, research, human resources development and education)
 - The cluster of engineering (it is the association of organizations engaged in engineering and related industry branches, it focuses on innovation engineering products and emphasizes the interdisciplinary cooperation)
 - Faculty of Mechanical Engineering, Brno University of Technology

Business models and practices

Role model companies

- Processing technologies including energy savings
 - BOCO PARDUBICE machines, s.r.o.
 - Borra s. r. o.
 - DATRIA s.r.o.
 - BUKO-S s.r.o.
 - COMPUPLAST s.r.o.
 - SEKON plast s.r.o.
- Technological waste management
 - PURUM
 - SOLLAU CZ s.r.o.
 - Magsy s.r.o.
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Zejatech s.r.o.

Relevant industrial groupings and networks

In the Czech Republic, companies from the machinery field oriented on the sustainability and circular economies are members of several clusters, platforms or associations. Some of them were mentioned above, for example Association of Engineering Technology, Czech Machinery Cluster or Cluster of engineering.

Conclusion

Slowing down the depletion of primary resources, consistent recycling of waste and its reuse, emphasis on quality of service and extending the durability of equipment and parts are the most basic ideas related to the circular economy. In the field of machine industry, the circular economy should be strongly linked to the ecodesign of production facilities towards robust, long-life and repairable designs. The focus should be on optimised production processes, both in terms of machine production and the services that production facilities provide to the plastics industry. In addition to advanced engineering or IT technologies, ecodesign should also be associated with new materials, including the use of secondary resources, or the minimisation of the environmental impact of production in the context of the use, consumption and recycling of water, the handling of chemicals from the perspective of the green chemistry principles, or the efficient and economical use of energy.

Germany

Policies and business support

Policy

The German side demonstrates the close interdependence between EU policies relating to the circular economy and environmental issues in general and national policies and strategies.

- Generic level
 - Germany's High-Tech Strategy 2025 (HTS 2025) – federal policy oriented towards innovation, technological advancement, cross-sector collaboration
 - Industry 4.0 Initiative (digital transformation of manufacturing)
- Material sourcing for plastic processing machine production
 - Circular Economy Action Plan (EU action plan focused on transition to a circular economy)
 - Raw Materials Strategy (federal policy on sourcing raw materials responsibly and sustainably)
- Processing technologies including energy savings
 - Energy Efficiency Strategy for Industry (Federal policy providing support for implementing energy-saving technologies in manufacturing)
 - Eco-Design Directive (EU directive)
- Technological waste management
 - Waste Electrical and Electronic Equipment Directive (WEEE) – EU directive on disposal and recycling of electronic waste
 - German Closed Substance Cycle and Waste Management Act (KrWG) – sustainable waste management and recycling
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - End-of-Life Vehicles Directive (EU policy connected with recycling and recovery of materials from vehicles but applicable to machine parts as well)
 - German Product Responsibility Program (producer responsibility for design products that are easier to recycle and refurbish)
 - Resource Efficiency Program (ProgRes) – federal programme for efficient use of resources throughout the product lifecycle.

National/regional strategic documents

Some of the national strategic documents have already been included in the more general overview of policy frameworks above (ProgRes, KrWG).

- Processing technologies including energy savings

- National Action Plan on Energy Efficiency (NAPE) – federal action plan supporting energy-efficient technologies
- Energy Concept 2050 (federal long-term strategy to reduce of energy consumption and enhance energy efficiency)
- Technological waste management
 - German Act on Corporate Due Diligence to Prevent Human Rights Violations in Supply Chains (LkSG)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - National Programme on Sustainable Consumption (federal programme focusing on reuse, refurbishing, and recycling of products and machinery)
 - Extended Producer Responsibility (EPR) Policy (federal policy deepening producer responsibility throughout the product life cycle)

Funding schemes and further business support measures

In the context of business support, the *Resource Efficiency Programme* (ProgRes) can be mentioned again

- Generic level
 - Central Innovation Programme for SMEs (ZIM) – support of collaboration between businesses and research institutions
 - High-Tech Start-Up Fund (HTGF) – support of innovative technologies
- Material sourcing for plastic processing machine production
 - Environmental Innovation Program (UIP) – support of large-scale innovative projects for reduction of pollution
- Processing technologies including energy savings
 - Energy Efficiency Programme (KfW) – focused on financing of energy efficiency measures for companies
 - BAFA (Federal Office for Economic Affairs and Export Control) Energy Consulting for SMEs – financial support and consulting services for transition to clean energy
- Technological waste management
 - Innovation Programme for the Circular Economy (Inno-KREIS) a platform to support technology-driven companies and foster collaboration between companies and research institutions in the field of circular economy
 - Life Programme – co-financing sustainable production projects at EU level
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - BMU Environmental Innovation Programme – support of developing innovative refurbishment technologies
 - EU Horizon 2020 - Circular Economy – EU funding of innovation projects promoting a circular economy

Technology and knowledge providers

The *Fraunhofer-Gesellschaft* is an important connection between all perspectives on the field of knowledge providers with an overlap into the application sphere. The institution is the leading organization for applied research in Europe. Its research activities are conducted by 76 institutes and research units at locations throughout Germany.

- Generic level
 - Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) – provides applied research in manufacturing, automation, and process engineering
 - Steinbeis Foundation (consulting and advisory company, SME support in obtaining projects and subsidies)
 - Baden-Württemberg International (BW_i) – central location marketing agency for business and science in Baden-Württemberg
- Material sourcing for plastic processing machine production
 - Fraunhofer Institute for Chemical Technology (ICT) – applied research in chemical technology and polymer processing
 - Karlsruhe Institute of Technology (KIT) – research and education in engineering and natural sciences.
- Processing technologies including energy savings
 - Fraunhofer Institute for Production Technology and Automation (IPT) – research and development in production technology.
 - University of Stuttgart - Institute of Energy Economics and Rational Energy Use (IER)
- Technological waste management
 - Fraunhofer Institute for Environmental, Safety, and Energy Technology (UMSICHT) – applied research in environmental technologies and resource management.
 - Institute for Industrial Ecology (INEC) – part of Pforzheim University, focuses on ecological and economic optimization of product life cycles and operational production processes
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Fraunhofer Institute for Machine Tools and Forming Technology (IWU) & Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) – Department of Remanufacturing (applied research in remanufacturing and refurbishing of used machine parts)
 - University of Stuttgart - Institute for Recycling (IfR)

Business models and practices

Role model companies

Baden-Württemberg is a hub for the manufacturing and engineering sectors, particularly known for its automotive industries and advanced machinery including the plastic processing machine industry. The innovative and advanced technologies used by producers not only enhance operational efficiency and sustainability but also contribute to the region's reputation as a leader in green manufacturing.

- Generic level
 - Festo (specializes in automation technology and industrial automation, emphasizes energy efficiency and environmental responsibility in its production processes)
- Material sourcing for plastic processing machine production
 - Arburg GmbH + Co. KG (leader in injection moulding machines manufacturing, focuses on sustainable material sourcing, recycling, high-quality production with minimal environmental impact)
 - Krauss Maffei Group (specializes in machinery for processing plastics and rubber and sustainable material sourcing)
- Processing technologies including energy savings
 - Trumpf Group (high-tech machine tools and laser technology company, provides energy-efficient and sustainable technologies)
 - Heidelberger Druckmaschinen AG (a leader in printing technology, focuses on energy-saving and innovative technologies)
- Technological waste management
 - Hahn Plastics GmbH (specializes in recycling plastic waste into high-quality products)
 - Remondis SE & Co. KG (recycling, service, and water company, provides recycling and reusing industrial waste)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Liebherr Group (a manufacturer of construction machinery equipment, implements extensive refurbishment and recycling programs for used machine parts)

Industrial groupings and networks associating companies from Baden-Württemberg

- Generic level
 - Innonet Kunststoff Cluster in Horb a.N. (a cluster focused on innovations and sustainability in plastics industry)
 - Allianz Industrie 4.0 Baden-Württemberg (focuses on the digital transformation of the manufacturing sector)

- Cluster Initiative Baden-Württemberg (supports partnerships between companies, research institutions and government)
- VDMA (Verband Deutscher Maschinen- und Anlagenbau)
- Material sourcing for plastic processing machine production
 - Kunststoff-Institut Lüdenscheid (service for plastics industry)
 - Plastics Europe Germany (network for plastics production sustainability)
- Processing technologies including energy savings
 - Institute for Industrial Production (IIP) at KIT (focuses on sustainability and energy efficiency in manufacturing)
- Technological waste management
 - Deutsches Institut für Normung (DIN)
 - Waste-to-Resources Network
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Circular Economy Initiative Deutschland
 - Remanufacturing Network Europe

Conclusion

Baden-Württemberg is characterized by its robust industrial landscape, cutting-edge technological advancements, and a strong commitment to sustainability. Strong engineering firms have support in policies and funding programmes for sustainability. The knowledge provider base is also broad. Nevertheless, barriers can be found that slow down the transition to a circular economy, such as regulatory complexity and high initial investment costs for sustainable technologies.

Hungary

Hungary is a major importer of engineering technology. Domestic engineering production is then concentrated mainly in large enterprises. This sectoral structure is not very favourable and reduces innovation capacity of sector.

Policies and business support

Policy

- Generic level
 - The Machinery Directive promotes the free movement of machinery within the single market guarantees a high level of protection for EU workers and citizens. The Directive has been updated to reflect technical progress and will enter into force in January 2027.
- Technological waste management & collection of used machine parts and their reintegration/ refurbishment/recycling
 - The National Waste Management Plan 2021–2027 including National Prevention Program (based on EU's Waste Management Plan)
 - MOHU (MOL Waste Management Ltd.) is only authorized company to handle all types of waste, including metal and machinery, as well as used machinery and equipment

National/regional strategic documents

- Generic level
 - Smart Specialization Strategies (S3) policy (R&D activities in cutting-edge technologies, digitalization, energy production and storage, resources management, circular economy)
- Processing technologies including energy savings
 - National Energy Strategy of Hungary until 2030 (low-carbon technologies for production of energy and heat)
- Technological waste management
 - Waste management plan of Ministry of Energy for 2023 & E-waste directive (WEEE Directive) in accordance with the EU Directive

Funding schemes and further business support measures

At present, there is no available funding in Hungary, but potential EU support may be expected in the future.

- Generic level
 - Hungarian Investment Promotion Agency (HIPA)
 - The Economic Development and Innovation Operational Program (due to the challenges in the discussion of Hungary with the EU these programs are currently not available)
- Financial tools
 - Hungary is moderately equipped with funding and investment opportunities when it comes to innovation towards machinery value chain.

Technologies and knowledge providers

- Generic level
 - Budapest University of Technology and Economics, Faculty of Mechanical Engineering, Department of Polymer Engineering (aging of polymers, polymers from renewable resources, (bio)active packaging etc.)
 - Scientific Association for Mechanical Engineering (public benefit association, mediating of world-leading manufacturing technologies and knowledge)
 - University of Pécs, Faculty of Engineering and Information Technology
 - Neumann János University, Faculty of Technology and Information Technology
- Material sourcing for plastic processing machine production
 - Hungarian Logistic and Sourcing Association (MLBKT) – non-profit organization in the domestic procurement and logistics industry
- Processing technologies including energy savings
 - AMCO Kft. (distributors of plastic packaging machines and packaging materials)
 - FANUC Hungary Kft. (industrial automation)
 - Robot-X (industrial automation)
- Technological waste management
 - Hungarian Association of Environmental Enterprises (HAEE) is the largest Hungarian environmental advocacy organization – coordination and education in this field
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - MOHU (MOL Waste Management Ltd.
 -

Business models and practices

Role model companies

- Generic level
 - Giga 2003 Kft. (CNC machines producer (programming, training, operating), single purpose machines, for plastic machinery producer)

- Material sourcing for plastic processing machine production
 - Polymeron Kft. (plastic and elastomers)
- Technological waste management
 - P.M.R. Ltd. (recycling of paper, plastic, and metal waste)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - BIOKOM Nonprofit Kft. (waste management in the city of Pécs)
 - MÜ-GU Kft. (acceptance, collection and management of scrapped and depreciated electrical and electronic equipment)

Industrial groupings and networks

- Generic level
 - Hungarian National Association of Machinery and Power Engineering Industries (MAGEOSZ) is a civil professional association, member of Orgalim organization, consultative partner for the EU institutions
- Processing technologies including energy savings
 - Southwest Hungarian Engineering Cluster (National Accredited Cluster title and owner of the ESCA Silver Label Certificate)
- Technological waste management
 - National Association of Waste Management (an interest representation organization of Hungarian waste recycling companies)

Conclusion

The Hungarian side mostly calls for expanding the knowledge base, education and appropriate economic environment. The availability of regional public financing to support innovation activities in the field of machinery industry is rather low.

Republic of Moldova

The Moldova focuses in particular on plastic waste management, collection, recycling, reuse, etc. As an EU candidate country, it aims to implement EU law in its national policies.

Policies and business support

Policy

- Generic level
 - Law 231/2010 on internal trade (Article 20) is connected with packaging (Retail restrictions – plastic bags)
 - Government Decision 972/2023 on the approval of the National Program for waste management for the years 2023–2027 (Priority directions/measures on management and material recovery of plastic waste)
 - Waste management Strategy (Regionalization of the waste management service)
 - Law 1540/1998 on payment for environmental pollution (pollution fees)
 - Government Decision 1296/2008 on how to collect environmental payments for the import of goods which, in the process of use, cause environmental pollution and for the packaging of import goods made of plastic and/or "tetra-pack"
 - Law on waste 209/2016
 - Article 12 Extended producer responsibility
 - Article 13 Recovery of waste
 - Article 54 Essential requirements for packaging placed on the market
 - Government Decision 561/2020 for the approval of the Regulation on packaging and packaging waste
 - Circular Economy Action Plan (plastics is identified as a key priority)
 - New Circular Economy Action Plan for a cleaner and more competitive Europe
 - Commission Regulation (EU) 2022/1616 of 15 September 2022 on recycled plastic materials and articles intended to come into contact with food, and repealing Regulation (EC) No .../... 282/2008

National/regional strategic documents

- Material sourcing for plastic processing machine production
 - Waste Management statistics in Republic of Moldova (2019-2022) – including generation, collection and recycling for plastic waste by codes
- Technological waste management
 - Feasibility studies on regional waste management on 3 Waste Management Regions (Ministry of Environment)
 - EPR end-of-life vehicles – Government decision 93/2023:

Funding schemes and further business support measures

- Processing technologies including energy savings & technological waste management
 - ODA funding programs (Government Decision Nr. 592/2019 on the approval of the Greening Programme for SME) SME Greening Program and re-technologization and energy efficiency program

In the context of promoting Moldova's economic transition towards sustainability and circularity, two projects are currently in progress:

- The Moldova Future Technologies Activity (FTA), funded by USAID, Sweden, and the United Kingdom (UK) continues
- EU-UNDP project Enabling an Inclusive Green Transition in the Republic of Moldova (launched in May 2024, encourages development of environmentally responsible businesses including the introduction of circular economy principles)

Technology and knowledge providers

- Generic level
 - E-Circular is NGO – they aim is promoting and implementing efficient and sustainable practices
- Material sourcing for plastic processing machine production & technological waste management
 - Alecu Russo State University of Bălți – Study of Materials, Engineering and Management in auto transport (focus on plastics)
 - Vocational School 5 (Balti) – Specialty Electrogas-welder-fitter – welding of plastic
 - Vocational school 2 (Cahul), Vocational School 3 (Chişinău), Vocational School Rezina – Specialty Locksmith-plumber – welding of plastic

Business models and practices

The plastic waste collection system in Moldova is well elaborated. Number of organisations implementing extended producer responsibility operate throughout the whole territory.

- Plastic waste EPR companies
 - Reciclare REICLARE is association for commitments concerning the extended responsibility of producers and importers (EPR) to meet their legal obligations regarding the recycling of packaging
 - Moldcontrol is an employers' association implementing extended producer responsibility to meet the legal obligation to collect and recycle waste electrical and electronic equipment (WEEE), waste batteries and accumulators (DBA), packaging waste (DAM) and waste tyres (SAD).

- EcoSave NGO is a platform implementing extended producer responsibility for collection and recycling waste electrical and electronic equipment (WEEE), batteries and accumulators (DBA), and packaging waste (DAM)
- EcoREP organisation for waste management
- Material sourcing for plastic processing machine production
 - Autovoiaj SRL (an importer and distributor of raw material for plastics processors, manufacturers of plastic goods and processor of plastic waste)
 - Uniplast SRL (producer of pipes and fittings made of PP, PVC, HDPE collector and processor of plastic waste)
- Companies focused on manufacturing of plastic product as well as recycling and reuse of plastic waste in production processes:
 - Gustoro SRL, AlexGrup SRL, Reciplast SRL, Rubiplast SRL, Gelu Com SRL
- Technological waste management
 - Export of plastic waste: Bambus Prim Ltd and Gelibert
 - Recycling of plastic waste: ABS Ltd and FinPlastPrim Ltd
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - There are 187 operator with authorisation to collect metal in Moldova
 - Moldrec, Moldcontrol, Eco-Recycling – collect electric and electronic Waste (WEEE).

Conclusion

The Moldovan side has prepared a thorough overview of the collection and treatment of plastic waste, including legislation related to this issue. The machinery industry in the country is concentrated on imports rather than own production. Moldova sees education, research and innovation as important issues, as well as further deepening the recycling system for plastics, especially packaging, including backups for plastic packaging.

Romania

Policies and business support

Policy

The legislative framework in Romania, which also includes the principles of circular economy, consists of a combination of national laws and transposition of EU directives and regulations.

- Generic level
 - Machinery directive (2006/42/EC) of the European Parliament and of the Council of 17 May 2006
 - Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery (It will repeal the existing directive 2006/42/EC from 2027)
 - Government Decision no. 1029/2008 regarding the conditions for introducing machines to the market (national government decision, essential safety requirements for machinery)
 - Government Decision no. 1215/2023 for approval of Romania's Long-Term Strategy for reducing greenhouse gas emissions - Romania Neutră în 2050 (national government decision regarding ecodesign requirements)
- Material sourcing for plastic processing machine production
 - Law No. 249/2015 on Packaging and Packaging Waste
- Processing technologies including energy savings
 - Ecodesign Directive (2009/125/EC) of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products
 - Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading
 - Law No. 121/2014 on Energy Efficiency (national law providing a legal framework for improving energy efficiency across sectors, including industrial manufacturing)
- Technological waste management
 - Law No. 211/2011 on Waste Management (national law on waste management including for end-of-life machinery, promoting waste prevention, recycling, and resource recovery)
- Collection of used machine parts and their reintegration/ refurbishment/ recycling
 - Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)
 - Law no. 42/2023 regarding the approval of the preparation procedures for the reuse of electrical and electronic equipment waste, the technical requirements

regarding the preparation for reuse and the requirements for reporting and monitoring of reused electrical and electronic equipment

National/regional strategic documents

- Generic level
 - The European Machine Tool Sector and the Circular Economy (a strategic document published by European association CECIMO provides recommendations to both the industry and policymakers to promote circular practices within the machine tool sector)
 - Extended Producer Responsibility (EPR) (Extended producer responsibility for the full lifecycle of their products and packaging)
 - National Strategy for the Circular Economy in Romania (Although engineering has only a minor share in the Romanian economy, this strategy promotes circular economy in machinery construction, machines and their components should be designed for disassembly during the design phase)
 - Romania's National Sustainable Development Strategy 2030 (aligns Romania's development policies with the United Nations Sustainable SDGs)
 - Romania's National Recovery and Resilience Plan (PNRR) (aimed at mitigating the socio-economic effects of the COVID-19 pandemic)
- Material sourcing for plastic processing machine production
 - Trends for Manufacturing Industry: A Strategic Roadmap Toward Industry 5.0 (is a strategic roadmap which evaluates the implications of Industry 4.0 and highlights the importance of automation, digitization, and sustainable production systems)
- Processing technologies including energy savings
 - National Energy Efficiency Action Plan (builds on previous stages of the strategy)
 - Romania's Long-Term Strategy for reducing greenhouse gas emissions - Romania Neutră în 2050 (strategy primarily focuses on achieving climate neutrality by 2050)
 - Romanian Energy Strategy 2016-2030, With An Outlook To 2050 (strategy for improving energy efficiency and integrating renewable energy into industrial processes)
- Technological waste management
 - National Waste Management Plan (document elaborated by National Environmental Protection Agency establishes objectives, measures, and indicators for preventing and reducing waste)

Funding schemes and further business support measures

Funding schemes

- Generic level
 - Horizon Europe (is the EU's funding program that supports research and innovation related to the circular economy)

- European Regional Development Fund (ERDF) (support for innovations related to resource efficiency and environmental impact reduction)
- LIFE Programme (programme for the environment and climate action)
- EIB – European Investment Bank (actively supports circular economy projects, including those related to machine manufacturing)
- Romania's National Recovery and Resilience Plan (PNRR) (Romania's National Recovery and Resilience Plan (europa.eu))
- PNCDI IV – National Plan for Research, Development, and Innovation 2022–2027 (strategic program that aims to advance research, innovation, and development in Romania)
- State Aid and De Minimis Support Scheme of October 19, 2023 (fostering the development of SMEs in fields of Industrial Facilities and Equipment, Circular Economy and Energy Efficiency, Advanced Manufacturing Technologies, Energy-Efficient and Sustainable Practices)
- Start-Up Nation – Romania (for stimulating the establishment of small and medium-sized enterprises)
- CONSTRUCT PLUS (national programme for the development of domestic production of products and construction materials)
- POR – Regional Operational Programme 2021-2027 (programme for strategic investments that enhance economic competitiveness, innovation, and sustainability)
- C-Voucher (circular economy funding scheme for SMEs)
- CEPU – Financing for Microenterprises and SMEs in the Southeast Region (Activities focused on creating durable, easy to repair, upgrade, reuse, and recycle products and fostering new business models and activities that support their integration into value chains)

Business support measures

- Generic level
 - EEN – Enterprise Europe Network () (supports companies to adopt circular practices and develop partnerships.)
 - AIPPIIMM – Romanian Agency for SMEs, Investment Attraction and Export Promotion (provides advisory services and business development support to help SMEs in the processing machinery sector)
 - ASPAPLAST – Association of Plastic Mass Processors from Romania (industry association that provides support and advocacy for machine and equipment manufacturers in the plastic sector)
- Material sourcing for plastic processing machine production

- ANPM – National Environmental Protection Agency (disseminates information on sustainable sourcing and environmental impact)
- CCIR – The Romanian Chamber of Commerce and Industry (training programs designed to educate entrepreneurs and manufacturers on sustainable practices)
- Processing technologies including energy savings
 - ARPEE – Romanian Association for the Promotion of Energy Efficiency (provides advisory services on implementing energy-efficient technologies and practices)
 - FREE – The Romanian Fund for Energy Efficiency (promoting investment in energy-efficient innovations)
 - ANRE – National Regulatory Authority for Energy (promoting investment in energy-efficient innovations)
- Technological waste management
 - A.R.M.D. – Romanian Association for Waste Management (promoting sustainable waste management practices)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - RoRec – Romanian Association for Recycling (non-profit organization with a significant role in managing waste electrical and electronic equipment)

Technology and knowledge providers

- Generic level
 - ARoTT – Romanian Technology Transfer and Innovation Network (platform for collaboration among technological transfer entities, incubators, parks, and innovative businesses)
 - INCDPM – The National Institute for Research and Development in Environmental Protection (research institute coordinated by the Ministry of Research and Innovation)
 - EXPO PLAST (business and networking platform in Romania for the plastics processing industry)
 - Econet Romania (German-Romanian initiative for cooperation in the area of sustainable technologies)
- Material sourcing for plastic processing machine production
 - University Politehnica of Bucharest (The Research Center for Advanced Materials, Products, and Processes; The Research Center for Intelligent Products, Processes, and Services)
 - ECOIND – National Institute for Research and Development in Industrial Ecology (institute focusing on sustainable manufacturing and industrial processes)
- Processing technologies including energy savings
 - Ministry of Energy
 - Technical University of Cluj-Napoca (research activities in the field of robotics)

- ICPE-CA – National Institute for Research and Development in Electrical Engineering (develops energy-efficient technologies and solutions that reduce power consumption in industrial machinery)
- Technological waste management
 - Eltex Recycling (leader in innovative industrial waste management)
 - AHK Romania's Waste Management and Recycling Project (collaboration and knowledge exchange in field of waste management)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - CITT – Centre for Innovation and Technology Transfer
 - BioProject BWS (waste collection services for both hazardous and non-hazardous industrial waste)

Business models and practices

Romania's plastic processing industry relies on a mix of domestically produced and internationally supplied machinery and equipment. A significant portion of machinery is imported.

Role model companies

- Generic level
 - Eurodac (production of industrial machinery and equipment with emphasis on safety)
- Material sourcing for plastic processing machine production
 - Compa S.A. (manufacturer of industrial components and machinery, integrate sustainable material sourcing practices)
 - Plastor S.A. (manufactures injection and blow moulds)
- Processing technologies including energy savings
 - Plastic Systems S.R.L. (manufacturer of plastics processing and recycling machinery with emphasis on incorporating energy-efficient technologies)
- Technological waste management
 - Plastics Bavaria (manufactures silos and storage systems for the plastic injection industry, develops systems for reduction waste generation during plastic processing by implementing recycling and reprocessing technologies)
 - RoRec Association
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - RoRec Association (has extensive programs for the collection and refurbishment of used electronic and electrical machine parts)
 - RematHolding (company collecting various types of industrial waste, including used machinery and equipment parts)

- GreenWEEE International S.A. (offers end-to-end recycling solutions for used industrial machinery (including plastic processing equipment), and focuses on recovering valuable materials from used machinery)
- Mecasoft (company specialized in designing, constructing, and integrating advanced automation solutions)

Industrial groupings and networks

Several groups (RoRec, A.R.M.D., ASPAPLAST) were mentioned earlier in connection with business support

- Generic level
 - Employers' Association of Plastic Mass Processors ASPAPLAST
 - 3R GREEN CLUSTER (the cluster focuses on the reuse of waste (biodegradable waste, WEEE, construction waste, textiles, used oil) as a raw material)
- Material sourcing for plastic processing machine production
 - Smart Alliance Innovation Technology Cluster (network of IT companies and technology providers, promotes innovation, sustainability, and digital transformation to improve the design and operation of machines including significant energy savings and process optimization)
- Processing technologies including energy savings
 - ACCER – Association of Energy Consuming Companies in Romania (It organizes training and certification programs for energy-efficient practices for industry, provides consultancy and advisory services)
- Technological waste management
 - A.R.M.D. – Romanian Association for Waste Management
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - RoRec – Romanian Association for Recycling

Conclusion

Plastic processing industry of Romania heavily relies on imported machinery for advanced and high-tech applications. The sector faces also challenges in complying with stringent environmental regulations, including the EU's push towards a circular economy. Implementation of resource-efficient and low-carbon technologies, designing for disassembly and recycling, and fostering innovation in smart manufacturing are key strategies.

Serbia

Policies and business support

Policy

Serbia is a candidate country of the European Union. However, their legislation closely mirrors and builds on EU legislation in all important areas, including the transition to a circular economy.

- Generic level
 - Environmental Protection Law (regulates integral system of environmental protection, recognizes the need to redefine various business/industry models in accordance with the principles of the circular economy)
 - Climate Change Law (regulates the system for the limitation of greenhouse gas emissions)
 - Strategic Environmental Impact Assessment Law (regulates the conditions, method and procedure for assessing the impact of certain plans and programs on the environment)
 - Rulebook on Machine Safety (requirements for health and safety protection related to the design and manufacture of machines, as well as their placing on the market and/or use)
- Processing technologies including energy savings
 - Law on Energy Efficiency and Rational Use of Energy (regulates the conditions and manner of efficient use of energy and energy products in the sector of energy production, transmission, distribution and consumption)
 - Law on the Use of Renewable Energy Sources (regulates the use of energy from renewable sources)
 - Regulation on determining the criteria for the allocation of incentives for attracting direct investments in the automation of existing capacities and innovation
- Technological waste management
 - Waste Management Law (regulates types and classification of waste, management planning responsibilities and obligations etc)
 - Regulation on waste disposal at landfills (prescribes conditions and criteria for design, construction and operation of waste landfills)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Rulebook on the conditions and method of collection, transport, storage, and treatment of waste used as secondary raw material or for obtaining energy

National/regional strategic documents

- Generic level
 - Roadmap for circular economy in Serbia (the document represents a guidance for transition to circular economy focusing, apart from the profit, on the protection of the environment and preservation of resources)
 - Smart Specialization Strategy of the Republic of Serbia 2020-2027 (identification of economically weaker areas and their development in compliance with the circular economy (extend the life, minimal waste generation, new business models))
 - Green Agenda for the Western Balkans (is a regional development strategy based on the European Green Deal and the related Economic and Investment Plan for the Western Balkans)
 - Program for the development of the circular economy in the Republic of Serbia for the period from 2022 to 2024
 - Industrial Policy Strategy 2021-2030 (the circular economy is one of the areas important for increasing the competitiveness of national industry)
- Processing technologies including energy savings
 - Strategy for low-carbon development of the Republic of Serbia (strategy for the period from 2023 to 2030 with projections until 2050, adopted according to the Law on Climate Change)
- Technological waste management
 - Waste management program in the Republic of Serbia for the period 2022–2031 (builds on the Waste Management Strategy for the period 2010–2019, should enable the realization of the prerequisites for the use of waste in the circular economy)

Funding schemes and further business support measures

Funding schemes

- Generic level
 - Support program for companies for the adoption of business principles in international value chains in 2023 (a financial support scheme of the Development Agency of Serbia for companies to improve their business)
 - Programs of the Innovation Fund of the Republic of Serbia, within which financial resources are allocated for the increase of innovation capacities and the growth of small and medium-sized enterprises)
 - "Innovation vouchers" program (a simple financial mechanism enabling SMEs to use the services of the scientific research sector and raise the level of innovation)
 - "EU for the Green Agenda in Serbia" (project with the technical and financial support of EU and Ministry of Environmental Protection, implemented by UNDP)

- with the Embassy of Sweden and the European Investment Bank, circular economy one of priority areas)
- Sustainable Europe Investment plan (promotion of ambition of a carbon-neutral Europe including countries that are not members of the EU at the moment)
- Processing technologies including energy savings
 - Support program for small and medium-sized enterprises for the purchase of equipment (programme by Ministry of Economy and Development Agency of Serbia, support of purchases of production equipment/construction machinery/machines and equipment for the improvement of energy efficiency and ecological aspects)
 - Several state aid schemes for compliance with new standards and investment in energy efficiency measures
- Technological waste management
 - Financing of waste management (waste collection and separation, expand market for recycled materials and exporting of non-processable waste)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - State aid for investment in recycling and reuse of waste (waste to resources, support of state-of-the-art technologies)

Business support measures

- Generic level
 - Development Agency of Serbia (agency of the Government of Serbia, support for direct investments, promotion of competitiveness and exports)
 - Center for Circular Economy of the Serbian Chamber of Commerce (promotion of the transition to a circular economy from policy to companies support)
 - Center for European Policies (an independent, non-governmental, non-profit think tank of group of experts in the field of European law, economics, and public administration - main goal is making policies more transparent, inclusive and oriented towards EU)
 - Center for Promotion of Circular Economy (promotes circular economy models, works with experts, initiates projects in the field of circular economy, and organizes meetings, seminars or workshops)
 - CirEkon (the mission is to modernize business systems in a responsible way through product-service life cycle management and inclusion in world trends following the principles of circular economy and sustainable development through education, implementation of circular models and elimination of waste)
 - Program "Strengthening and further establishment of mentoring services for small and medium-sized enterprises in the Western Balkan countries" (mentoring service for SMEs supported by the Development Agency of Serbia and the Japanese Agency for International Cooperation)

- Processing technologies including energy savings
 - Resalta (company that provides professional assistance in consulting and implementing solutions to increase energy efficiency for industrial companies.)
- Technological waste management
 - Consulting services of various companies in the field of waste management (significant number of independent business entities provide consulting and related services in the field of waste management – e.g., JOB doo, BIS Recycling Center, Higia doo, Esotron, Desanio.)

Technology and knowledge providers

- Generic level
 - Center for Green Economy, University of Kragujevac (fostering collaboration between the academic community and relevant stakeholders in the fields of economics, engineering, law, and ecology, a hub that encourages the sharing of knowledge and experiences among companies and individuals)
 - University of Belgrade
 - Faculty of Organizational Sciences – Master module Circular Economy
 - Innovation Center of the Faculty of Mechanical Engineering (knowledge base)
 - “Mihailo Pupin” Institute (Center for Science and Technology Development Research stands out focusing on research and synthesis of development strategies, policies, plans, and programs with goal of increasing the efficiency of investment in research and development and innovation activities)
 - Institute of Mining and Metallurgy, Bor (implements scientific research projects in the fields of geology, mining, metallurgy, and technology, but also in the field of new materials, technologies, devices, equipment, environmental protection and material recycling)
- Material sourcing for plastic processing machine production
 - University of Novi Sad, Faculty of Technical Sciences, Department of Production Engineering (five study modules - Computer-aided technologies, Modern material shaping technologies, Modern plastic shaping technologies, Precision engineering, and Mechanical software)
- Technological waste management
 - University of Novi Sad, Center for waste management and material flow analysis (deals with research in the field of waste management)

Business models and practices

Role model companies

- Generic level
 - Tri Project + about 10 other companies with similar profile (company focuses on sale, installation, and servicing of plastic processing machines as exclusive

- representative of the German company KraussMaffei and partner of Yaskawa – manufacturer of industrial robots)
 - Material sourcing for plastic processing machine production
 - Technofoam (designs, develops, and manufactures machines for the lamination, cutting, profiling, and packaging of sponges, automation of production processes, and palletizing)
- Processing technologies including energy savings & technological waste management
 - Neofyton (general representative of the world's largest machine manufacturers and related equipment for the plastics industry)
 - Eko Servis (specializes in the collection, sorting, and recycling of plastic waste, primarily plastic films in which principles of saving electricity are applied)
 - Brzan plast (deals with waste packaging plastic recycling and the production and processing of granulate, the company also produced own mill for grinding PET packaging)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - SET reciklaža (private company that deals with the recycling of electronic and electrical waste)
 - DS Smith (a supplier of sustainable packaging solutions, paper, and recycling services worldwide, company offers several different recycling and recovery options to keep resources in the economy for as long as possible)

Industrial groupings and networks

- Generic level
 - Union of Engineers and Technicians of Serbia (a professional, expert-technical organization, which performs consulting activities in the field of mechanical industry)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - Association of Recyclers of Serbia (a group of companies involved in recycling various types of waste in Serbia)

Conclusion

The Serbian machine industry faces several challenges on the road to circular transformation, ranging from lack of awareness, and legislative and financial constraints, to insufficient infrastructure or technological gaps. However, Serbia sees these challenges as opportunities for improvement as it considers the machine industry as one of the most promising for strengthening competitiveness in the global market.

Slovak Republic

Policies and business support

Policies

Slovak Republic has policies, programmes and business support mechanisms to foster the growth and competitiveness of its machinery industry.

- Government Programs and Initiatives (include financial incentives, grants, and subsidies to encourage investment, innovation, and exports within the sector machinery industry)
- Research and Development (R&D) Support (the government funding and support for research and development activities in the machinery industry)
- Export Promotion (involves trade missions, participation in international trade fairs and exhibitions, and assistance with market research and entry into foreign markets)
- Skills Development and Training (the government supports vocational training programs, apprenticeships, and initiatives to upskill and reskill workers)
- Infrastructure Development (the government investments into infrastructure projects – road and rail networks, ports, and energy infrastructure)
- Cluster Development (clusters unite companies, research institutions, and other stakeholders to promote collaboration, knowledge sharing, and innovation)
- Regulatory Framework (the government regulatory framework establishes and enforces safety, quality and environmental standards that govern the engineering industry)
- Financial Support and Incentives (financial support and incentives, tax breaks, reduced tariffs on imported machinery components, access to low-interest loans or venture capital)

National/regional strategic documents

- Ministry of Environment of the Slovak Republic (responsible for developing and implementing environmental policies related to waste management and circular economy including national strategies)
- SAŽP – Slovak Environmental Agency (main environmental authority in Slovakia and is responsible for environmental monitoring, assessment, and reporting)
- National Waste Management Plan
- European Union Directives and Reports (Slovakia adopts EU directives and regulations related to waste management, circular economy as well as EU Plastic Strategy and Circular Economy Action Plan)

Funding schemes and further business support measures

Funding schemes

In the area of funding schemes, Slovakia refers in particular to the EU Funding & Tenders Portal, where calls for projects supported by EU funds are published.

- Generic level
 - EU Funding & Tenders Portal (call for proposals, project and result overview, finding partners for project and business)
 - Ministry of Economy of Slovak Republic (subsidies, investment support, structural funds, recovery plan, etc.)
 - Slovak Chamber of Commerce and Industry (8 regional SCCI)
- Material sourcing for plastic processing machine production & processing technologies including energy savings
 - SARIO – Slovak Investment and Trade Development Agency (state agency of the Slovak Republic, belongs to the competence of the Ministry of Economy of the Slovak Republic.)
- Technological waste management
 - Eurostars, Eureka (SME support programmes – public network for international cooperation in R&D and innovation)
- Collection of used machine parts and their reintegration/refurbishment/recycling
 - EU Funding & Tenders Portal
 - Interreg Danube Region, Interreg Central Europe
 - Eurostars, Eureka (SME support programmes – public network for international cooperation in R&D and innovation)

Business support measures

- Generic level
 - Ministry of Economy of Slovak Republic
 - Slovak Investment and Trade Development Agency
 - National Recycling Agency of Slovak Republic (network and support for circular economy)
- Material sourcing for plastic processing machine production
 - PR Krajné, s.r.o. – owns technology for the production of recycled products
- Processing technologies including energy savings
 - W Service (after-sales service of injection moulding machines, hydraulic equipment, their preventive maintenance and modification associated with automation)
- Technological waste management
 - ESOX-PLAST s.r.o. (sorted recycled polypropylene, 100% recyclable and suitable for further production of a new product)

- Collection of used machine parts and their reintegration/refurbishment/recycling
 - IT EUROPE s.r.o. (used machine tools and drilling machines)
 - Tech Production s.r.o. (equipment repairs, spare parts production and equipment refurbishment)
 - KOVOHUŤ, s. r. o. (machine tool repairs, spare parts and accessories, sale of used equipment)
 - STAP spol. s r.o. (machine tool repairs, spare parts and accessories, sale of used equipment)
 - Kovona s.r.o. (machine tool repairs, spare parts and accessories)
 - J TECHNIK, s.r.o. (machine tool repairs, spare parts and accessories, sale of used equipment)
 - LEMAKOR, spol. s r.o. (overhauls and modernizations of machine tools including CNC)
 - VINKOOPER s.r.o. (sale and service of used metal-working and forming machines)

Conclusion

Slovakia focused its attention on the future direction of the machinery industry. It focuses on digitalization, automation, cyber security, etc. However, they did not forget to mention the need for sustainability and energy efficiency.

Summary

The Danube region is an area that runs through the territory of nine countries. The economy of each of these countries or regions is differently strong and mature, which is also reflected in the machine industry. It is not only the turnover achieved by the machine industry in general, but in this case also the ratio of the production of machinery for the plastics industry to the total machine production. Due to the different levels of each economy, it is difficult to find a complete consensus on the key questions posed by each region in the context of the transition to a circular economy.

Germany, or Baden-Württemberg, and Austria are strong players in the field of machinery for the plastics industry, especially in terms of core processing equipment and large process units such as injection moulding machines and lines, extrusion equipment, blow moulding lines, etc. Other regions are more dependent on imports of such equipment, with own production concentrating more on the production of moulds and other tools, smaller technological units, as well as servicing and repair of production equipment.

It can also be noted that Germany and Austria are well ahead of the others on the path towards a circular economy. Although they have managed many challenges well, they still face various obstacles, ranging from the complexities of regulation to the high initial investment costs of sustainable technologies and the need for continuous innovation to keep manufacturers ahead in a competitive global market.

Austria also identifies the lack of political incentives and the need for a change in mindset as barriers to transformation. Addressing these challenges demands a concerted effort from industry, policy makers and society as a whole. Without adequate support and incentives from policy makers, businesses may hesitate to embark on the path of transformation towards a circular economy. Education, awareness campaigns that value sustainability and cross-sectoral collaboration are essential for the adoption of circular economy principles in society.

Hungary sees a significant challenge in expanding the knowledge base and education, but also in establishing a supportive economic environment. They state that the availability of regional public financing to support R&D&I activities in the field of machinery industry is low. There are limited funds through local government initiatives, and only occasional funding from the European Regional Development Fund or other EU programs.

Romania has identified the high share of imports of equipment, especially advanced technologies, as one of the challenges it faces in the transition to a circular economy. The industry is thus vulnerable to fluctuations in global supply chains and foreign exchange rates, affecting the cost and availability of essential equipment. The introduction of digital

technologies and smart manufacturing solutions can increase operational efficiency, reduce costs and improve product quality. Investing in Industry 4.0 initiatives, such as predictive maintenance and real-time data analysis, can be crucial to maintain competitiveness.

The Slovak Republic also foresees the need to focus on improving production techniques. In addition to the use of advanced materials and technologies, it also relies on developing more intelligent, adaptable, and collaborative robotic systems and enhancing automation technologies for improved efficiency, safety, and flexibility in manufacturing processes. The adoption of digital technologies and the principles of Industry 4.0 can be beneficial as well as developing smart, interconnected systems, utilising big data analytics, artificial intelligence, or machine learning for predictive maintenance etc. This may involve designing eco-friendly manufacturing processes, reducing resource consumption, improving recycling and waste management practices, and integrating renewable energy sources into machinery operations.

Bosnia and Herzegovina, Moldova and Serbia are European Union candidate countries and are therefore committed to integrating EU legislation and strategic plans into national policies and strategies. They are therefore well prepared for the transition towards a circular economy and sustainability. However, like other countries, they face challenges such as high initial investments, insufficient infrastructure or low awareness. Nevertheless, Serbia, for example, sees the machine industry as one of the sectors of their economy that has a high potential to transition to a circular economy. Moldova emphasises the need for training and support for research and innovation. Bosnia and Herzegovina also mention limited stakeholders' awareness and availability of sustainable materials as a problem. However, educational initiatives and investment in research offer solutions. Other obstacles are outdated technologies and inadequate waste management infrastructure, but the adoption of energy efficient technologies and advanced recycling methods can help solve these problems.

The Czech Republic is the last of the participating countries. They also identify the problem of low awareness of the circular economy in society, but also among technology producers. There is a need to talk and educate not only about the use of non-renewable resources or the recycling of plastics, but also about water consumption or the toxic impacts of technologies and waste. They consider the eco-design of production facilities, which reflects well on all phases of the life cycle and leads to the design of robust machines with long life, repairability and energy-efficient operation, as an outstanding support on the way to the circular economy.

In conclusion, the Danube region faces many challenges on the path to circular transformation of the machine industry. However, the principles of the circular economy

promise significant environmental as well as economic benefits and increased competitiveness.