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DEVELOPMENT OF LOCALIZED PRODUCTION AND PROCESSING SYSTEMS AS A FOUNDATION FOR BUILDING A CIRCULAR ECONOMY IN RESOURCE-DEPENDENT REGIONS

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Abstract:
The article explores the potential for developing localized production and processing systems in resource-dependent regions as a foundation for building a circular economy. It analyzes the economic, infrastructural, and institutional prerequisites for their effective functioning, as well as their role in reducing import dependence, enhancing on-site raw material processing, and establishing stable regional economic models. The significance of such systems is emphasized in terms of increasing economic self-sufficiency, resilience to external shocks, and employment diversification. The paper also examines case examples of implementing localized production and processing systems in regions characterized by a high share of extractive industries and structural constraints. The conclusion underscores the need for an integrated approach to the development of such models as a tool for territorial transformation.

JEL: Q57, R11, O18, O25.

Keywords: localized production and processing systems, circular economy, supply chains, resource-dependent regions, processing, resilience

1. Introduction

The modern economic system, particularly in resource-dependent regions, faces a range of challenges stemming from fluctuations in global market conditions, disruptions in international supply chains, and a limited degree of diversification within the production base. The traditional model of natural resource exploitation, followed by the export of raw materials, results in the loss of added value, increased logistical risks, and reduced resilience of regional economies. In this context, the paradigm of a circular economy is gaining increasing relevance. This approach emphasizes the maximal integration of

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resources into local production and processing systems (LPPS) while minimizing waste and dependence on external supply sources.

The aim of this study is to analyze the potential of LPPS as a foundation for building circular regional economies under conditions of resource dependence. The study explores the economic and infrastructural prerequisites for the effective operation of such systems, their role in enhancing regional resilience and self-sufficiency, as well as the prospects for reducing import dependency through the advancement of domestic processing capacities.

2. Main part. Challenges of developing circular models in resource-dependent regions

The circular economy is a long-term production and consumption system based on regeneration, reuse, and recycling principles of materials [1]. Against the linear strategy – extraction, manufacturing, use, and disposal – the circular strategy attempts to extend product life cycles, reduce waste, and preserve the raw material value at every stage (Figure 1).

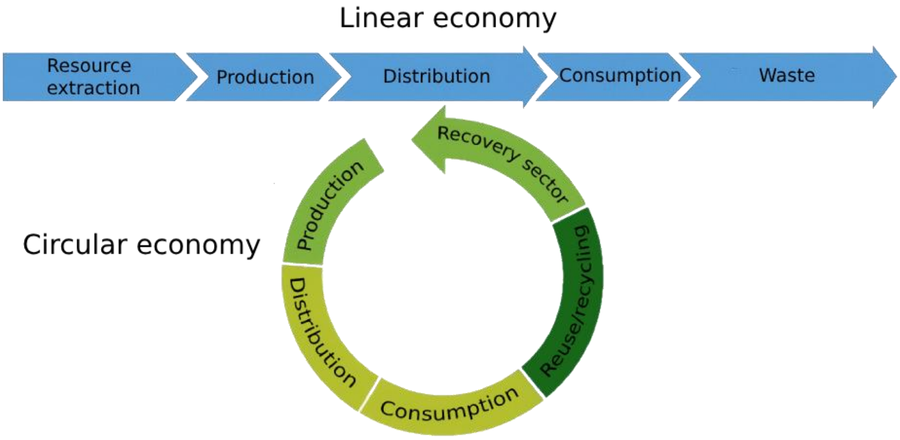

Figure 1: Comparison of linear and circular economies

Despite efforts undertaken in various countries to implement circular practices and develop recycling infrastructure, the global rate of secondary resource utilization significantly lags behind the pace of economic growth and the prevailing consumer behavior model. According to the 2025 report by the Circle Economy think tank, only 6.9% of the 106 billion tons of materials annually used in the global economy are derived from recycled sources, indicating a critically low level of circularity in global material flows (Figure 2).

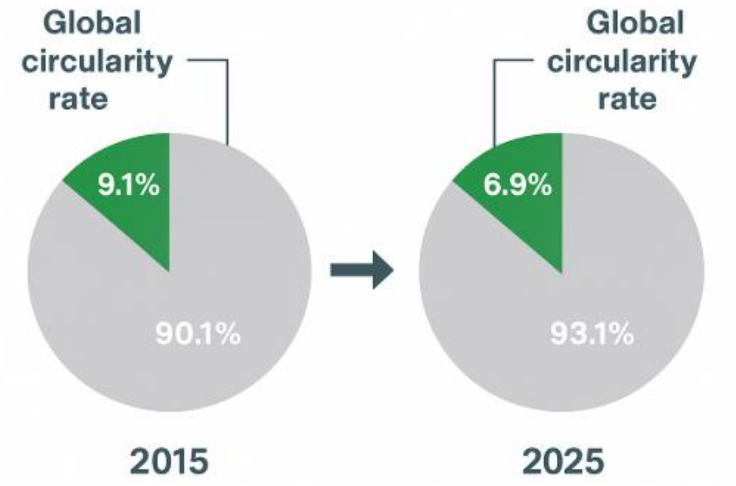

Figure 2: Dynamics of the global circularity rate [2]

The systemic causes of the problem are in the simultaneous rise of world population and consumption levels, a reflection of an increasingly material-intensive pattern of world development. Whereas material per capita consumption was 8,4 tonnes in 1970, by 2020 it had reached 12,2 tonnes. In the meantime, resource distribution remains highly unequal: individuals in affluent countries consume an average of 24 tonnes of material per year, whereas in developing countries this consumption does not exceed 4 tonnes.

Structural transformation toward a circular economy remains limited, partly due to the uneven spatial distribution of production and recycling capacities. According to an analysis by EEA, the gap in municipal waste recycling rates between the countries with the highest and lowest performance is considerable – 69% in Germany compared to 12% in Romania [3].

In the U.S., recycling was performed for only 21% of household waste as of a 2024 report by The Recycling Partnership [4]. In the states of Alabama, Louisiana, Mississippi, Montana, and Nebraska, residential recycling is below 10%, and recycling above 30% is reported by only four states: California, Connecticut, New York, and Oregon. EPR policy is being adopted by California, Colorado, Maine, and Oregon, it is seen.

One of the greatest challenges in transitioning to a circular economy is scaling up industrial production and recycling to match rates of material consumption. Heavy industry remains highly material- and energy-intensive, and reuse and recycling infrastructure is not yet well established. Industry consumes over 70% of global resources, but industrial waste is recycled only 16%, and fewer than 10% are reusable in industries like metallurgy and construction, according to the IRP (2024). According to the OECD (2023), 20% of industrial scrap metal is recycled, though technically appropriate, because of technological limitations, lack of incentives, and fragmented infrastructure.

In the context of developing a circular economy, resource-dependent regions warrant particular attention. These territories are characterized by a high share of extractive industries in the structure of gross regional product and face a range of persistent socio-economic and infrastructural constraints that hinder development and increase their vulnerability to external shocks.

One of the primary challenges for resource-dependent areas is the low level of local raw material processing. The extraction of natural resources without subsequent transformation into high value-added products results in capital outflow, limited employment opportunities, and heightened external economic vulnerability. A notable example can be found in resource-dependent regions of the U.S., such as Appalachia (West Virginia, Eastern Kentucky, Pennsylvania) and the western coal-producing states (Wyoming, Montana, Colorado, Mississippi), which together account for approximately 56% of the nation's coal production, with Wyoming alone contributing 41%. Despite the scale of extraction, only primary coal preparation (such as sorting and washing) is carried out locally, while further processing and value generation occur outside these territories. Second, the role of infrastructural asymmetry is a critical one in the guise of a lack of provision of transport, energy, and logistics infrastructure. The reality that a majority of the resource-based zones are geographically distant or inaccessible zones makes the issue worse by increasing the cost of establishment and maintenance of infrastructure, limiting access to processing capacity, and discouraging incorporation into sustainable value chains.

In addition to physical infrastructure constraints, a significant barrier is the shortage of qualified labor, particularly in regions with a mono-sectoral economic structure. There is a steady outflow of skilled professionals to more diversified regions, complicating the implementation of high-tech and processing projects at the local level. Finally, institutional limitations – including underdeveloped public-private partnership mechanisms, weak coordination between levels of government, and regulatory instability – further constrain the potential for comprehensive regional economic transformation. Investment programs in such regions are often not geared toward the systemic development of production and processing chains but are instead focused on maintaining existing extractive capacities. The need for stable partnerships between business and government is underscored by evidence that such forms of collaboration enable the removal of institutional barriers, foster long-term production linkages, and support the reproduction of locally generated added value [5].

3. Potential of local production and processing systems

The development of LPPS represents a promising direction for transforming the economies of resource-dependent regions toward greater resilience, technological independence, and the internal retention of added value. Unlike the traditional model focused on the export of unprocessed raw materials, local processing chains create opportunities for import substitution, stimulate economic diversification, and reduce logistical costs (Table 1).

Table 1: Effects of implementing LPPS [6, 7]

Impact area	Effect description	Relevant evaluation indicators
Economic resilience	Reduced dependence on external markets and commodity price volatility.	Share of manufacturing in Gross State Product (%); coefficient of budget revenue variation.
Import substitution	Replacement of imported inputs with locally processed materials.	Share of imported goods in regional consumption (%); share of domestic production in sectoral supply (%).
Logistical efficiency	Shortened transportation distances and reduced logistics costs.	Average freight distance (miles); logistics costs per ton-mile (USD/ton-mile)
Value-added creation	Increased local value generation through multi-stage resource processing.	Value added per ton of raw material (USD/ton); share of recycled or processed output (%).
Job creation	Employment growth in manufacturing and supporting industries.	Share of workforce employed in manufacturing (%); official unemployment rate (%).
Reducing outmigration	Retention of population through local employment and income growth.	Net migration rate; share of workers under age 35 in manufacturing (%).
Environmental performance	Lower environmental impact due to reduced waste and emissions.	Recycling rate (% of total waste); CO_2 emissions per million USD of GSP (t/USD million).
Infrastructure development	Expansion of industrial, energy, and transport infrastructure.	Capital investment in infrastructure (million USD/year); new capacity commissioned (sq ft, MW, tons/year).

An example of a successful transition toward elements of a circular economy in a resource-dependent region is the initiative implemented in Appalachia – specifically in the states of West Virginia, Ohio, Kentucky, and Pennsylvania. In this historically coal-reliant region, projects have been launched to process coal ash accumulated in over 400 ash disposal sites, with a total volume exceeding 2 billion tons. Instead of conventional landfilling, the ash is now used as a component in the production of cement and concrete, which reduces the consumption of virgin raw materials and lowers CO_2 emissions by 25-30% [8]. This processing is undertaken on the site of now-closed coal-fired power stations, thereby ensuring territorial localization of the whole production value chain of processing. Besides its contribution to the economy, the initiative assists in the reclamation of previously degraded land and reduces the risk of water pollution, thereby supporting a more sustainable industrial base and reducing the region's dependence on raw material exports.

Another illustrative example of an LPPS in a resource-dependent region is the project based on the Mountain Pass rare earth element (REE) deposit in California. This site represents a unique attempt to integrate all stages of the production chain – from extraction to the output of advanced components. Mountain Pass remains the only active facility of its kind in the U.S.: in 2024, it produced over 45,000 tons of rare earth oxide concentrate (up from 41,557 tons in 2023), accounting for nearly the entirety of domestic

REE output [9]. Additionally, in 2023 the site produced 200 tons of NdPr oxide, while MP Materials reported $253,4 million in revenue, $24,3 million in net income, and $102,5 million in EBITDA. These figures reflect not only the project's economic viability but also its potential to become a core for localized REE processing and future permanent magnet production in the U.S.

4. Infrastructure and economic conditions for the effective functioning of LPPS

The effective operation of LPPS in resource-dependent regions directly depends on the quality of the infrastructural environment and the availability of economic resources. Unlike centralized production models, LPPS require the coordinated development of transport and energy infrastructure, ready-to-use industrial sites, as well as financing mechanisms and institutional support. These conditions form the systemic foundation for technological resilience, reduced transaction costs, and the stimulation of on-site processing – factors that are especially critical in regions characterized by spatial dispersion and logistical constraints (Table 2).

Table 2: Critical infrastructure and economic conditions for LPPS and associated risk factors

Component	Role in LPPS functioning	Risk factors in case of deficit
Energy infrastructure	Ensures a reliable and affordable energy supply for processing operations.	Increased production costs; operational disruptions; reduced investment attractiveness.
Transport accessibility	Enables efficient inbound and outbound logistics.	Higher logistics costs, supply chain disruptions, and limited market access.
Industrial site readiness	Reduces entry barriers for SMEs and enables scalable production.	Lack of localization opportunities; relocation of projects to other regions.
Access to capital	Facilitates investment in equipment and processing facilities.	Underfinancing of projects, limited innovation, and delayed capacity expansion.
Regulatory environment	Provides incentives for local processing and material reuse.	Weak investor motivation; reduced competitiveness of locally produced goods.
Workforce availability	Supports operational scaling and technological adoption.	Decreased productivity; rising retraining costs; skilled labor shortages.
Innovation and clustering	Enhances regional specialization, cooperation, and resource efficiency	Lack of technological differentiation; weak integration into global value chains

Thus, the smooth functioning of LPPS is dependent on a balanced pair of infrastructural and economic factors supplementing one another in strengthening the effectiveness and resilience of the entire value chain. Any imbalance in any of the factors – energy supply, logistics, availability of finances, or human skills – gives rise to systemic risks that hinder local processing and restrict the generation of added value in the area. Spurring these deficiencies comprehensively demands coordinated effort at the federal, regional, and local levels of government, focused on long-term investment, cluster model building, and strengthening institutions for the processing industry.

5. Impact on the resilience and self-sufficiency of regional economies

Integrating LPPS into regional economic structures assists in paving the way for transitioning from a resources-export to a circular economy, on whose pillars recycling, reuse, and internal logistics become the bases of socio-economic stability and balance with the natural environment. In general, such localization is gaining its value in the context of increasing geoeconomic uncertainty, such as the placement of tariffs by the U.S. and other modifications of trade policy, which highlight the significance of enhancing regions' internal industrial potential.

First and foremost, LPPS enhance resource resilience by reducing dependence on external supplies of raw materials, components, and technologies. By processing locally available resources and applying reuse technologies, regions can lower their critical reliance on global supply chains – a particularly important factor amid geopolitical instability, sanctions, and disruptions in logistics. The localization of production circuits strengthens the adaptive capacity of regional economies, mitigating fluctuations in capacity utilization and employment. According to McKinsey surveys, 73% of companies have initiated dual-sourcing strategies, while 60% have begun regionalizing their supply chains to reduce disruption risks and increase resilience.

A second key aspect is the increase in regional economic self-sufficiency. LPPS enable the formation of closed-loop production cycles in which resources are extracted, processed, used, and recycled primarily within the same territory. This supports the accumulation of added value within the region, strengthens the tax base, and fosters the development of small and medium-sized enterprises in adjacent sectors such as logistics, repair, raw material preparation, and reuse. For example, estimates by the EPA and Union of Concerned Scientists suggest that «clean-closure» coal ash remediation projects in Ohio and Kentucky could generate over $100 million in additional economic activity. Such an approach gradually establishes a localized production–consumption balance, reducing dependency on interregional and external economic flows.

At the social level, the development of LPPS contributes to job retention and the engagement of local labor in sustainable, non-extractive industries – particularly relevant for regions with mono-sectoral economies. According to the Union of Concerned Scientists, investigations show that «clean-closure» coal ash plants would bring Kentucky as many as 282 jobs annually and Ohio 314 jobs annually in the construction phase (4 and 9 years, respectively). Growth in employment in processing, logistics, and waste management is supplemented by rising incomes and social infrastructure development. Such engagement also creates professional mobility and the acquisition of new skills in the area of safe waste disposal, pollution measurement, recycled building materials, and closed-loop logistics management.

From an ecological perspective, LPPS are a powerful tool for minimizing ecological footprint and increasing territorial environmental resistance. Use of secondary material, waste reduction, and transportation operations optimization significantly reduce greenhouse gas emissions and decrease the burden on ecosystems [10]. According to the EPA, municipal solid waste recycling and composting in 2023-2024 have avoided approximately 193 million metric tons of CO_2-equivalent emissions – equal to a year's emissions by around 42 million light-duty passenger vehicles in the U.S. Recycling aluminum also requires only around 5% of the energy needed to produce primary metal, reducing emissions by up to 95% compared to virgin aluminum.

Thus, integration of LPPS into the economic structure of resource-dependent economies not only smooths the transition towards a circular model of growth but also shapes strategic pillars for greater autonomy, resilience, and growth inclusivity. LPPS redefine such economies not only as raw material suppliers but as full industrial and socially sustainable actors in domestic and international economic networks.

6. Conclusion

The development of LPPS serves as a key instrument for the structural transformation of resource-dependent regional economies toward greater resilience, self-sufficiency, and integration into circular economic models. The implementation of LPPS helps decrease the export of raw materials with low value-added, decrease the reliance on external supplies, diversify the regional economy, and form territorially closed production cycles. In so doing, it generates employment, a consolidated tax base, and improved environmental outcomes by means of increased processing levels and waste reduction.

Successful LPPS realization must be supported by highly developed transport and energy infrastructure, industrial land immediately ready for use, accessible financing tools, and an institutional enabling framework. Together, these form the foundation for long-term growth of resource-rich areas into sustainably developing industrial areas, where local resources are exploited with optimum economic and environmental efficiency. LPPS creation can thus be regarded as a systemic prerequisite to fostering circular economy principles on a regional level.

Conflict of Interest Statement
The author declares no conflicts of interest.

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References

1. Abdullina L, 2024. Mechanisms of adaptation of small and medium enterprises to the circular economy: international practices. Znanstvena misel journal 96: 20-23. doi: 10.5281/zenodo.14242172
2. Circularity Gap Report 2025 / Circle Economy // URL: https://circularity-gap.world/2025 (date of access: 01.08.2025).
3. Waste recycling in Europe / EEA // URL: https://www.eea.europa.eu/en/analysis/indicators/waste-recycling-in-europe (date of access: 01.08.2025).
4. The Recycling Partnership's State of Recycling Report / The Recycling Partnership // URL: https://recyclingpartnership.org/report-shows-only-21-of-u-s-residential-recyclables-are-captured-points-to-policy-and-investment-as-immediate-solutions (date of access: 01.08.2025).
5. Nikitenko O, 2025. Models for building sustainable business partnerships in the packaging industry: the role of collaborative innovations and environmental strategies. German International Journal of Modern Science 104: 13-16. doi: 10.5281/zenodo.15476763
6. Agarwal A, Ojha R, 2024. Prioritizing implications of Industry-4.0 on the sustainable development goals: A perspective from the analytic hierarchy process in manufacturing operations. Journal of Cleaner Production 444: 141189. doi: 10.1016/j.jclepro.2024.141189
7. Nikitenko O, 2025. The role of sustainable packaging solutions in implementing corporate social responsibility: impact on business sustainability. Annali d'Italia 63: 69-71. doi: 10.5281/zenodo.14726811
8. Turning Liabilities into Opportunities: Coal Ash and the Cement and Concrete Industries 4 / Appalachia // URL: https://reimagineappalachia.org/wp-content/uploads/2024/11/Turning-Liabilities-into-Opportunities_Coal-Ash-and-the-Cement-and-Concrete-Industries_11-2024.pdf (date of access: 04.08.2025).
9. MP Materials Restores U.S. Rare Earth Magnet Production / Mountain Pass // URL: https://investors.mpmaterials.com/investor-news/news-details/2025/MP-Materials-Restores-U.S.-Rare-Earth-Magnet-Production/default.aspx (date of access: 04.08.2025).
10. Abdykalykov A, 2025. Civil liability for environmental damage. International Journal of Professional Science 3(1): 123-129.