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Industrial Symbiosis in Small Open Economies: A Quintuple Helix Assessment of Systemic Readiness in Latvia

Industrial symbiosis is widely recognised as a practical approach to advancing the principles of the circular economy. However, its successful implementation depends not only on technological capabilities, but also on the broader institutional context, stakeholder awareness, and the quality of cross-sectoral collaboration. This study examines Latvia's systemic readiness for industrial symbiosis using data from a representative survey (n = 230) conducted among stakeholders from the business sector, public administration, academia, and civil society. The findings point to a clear discrepancy between the strategic recognition of industrial symbiosis and the actual capacity to implement it in practice. Key barriers include limited stakeholder knowledge, insufficient availability of data on resource flows, low levels of trust between sectors, and a lack of effective economic incentives. At the same time, respondents acknowledge the significant potential of industrial symbiosis to reduce waste, improve resource efficiency, and foster innovation in business models, as well as to contribute to local resilience and competitiveness.

To further explore these systemic challenges, the study draws on the Industrial Symbiosis Sandbox simulation game, which applies a quintuple helix approach by dividing participants into five stakeholder groups. The simulation challenges participants to identify and operationalise industrial symbiosis opportunities under crisis conditions by aligning diverse stakeholder interests, matching resource flows, and evaluating solutions through multi-criteria performance indicators. The results of this approach highlight the complexity of balancing economic, environmental, and social objectives, while simultaneously addressing inter-sectoral conflicts and ensuring feasibility in a resource-constrained and uncertain environment. Building on the quintuple helix framework, the study argues that bridging the gap between policy ambition and practical implementation requires coordinated policy action, targeted economic instruments, the development of digital infrastructures, and systematic capacity building across stakeholder groups. By providing empirically grounded insights, the study contributes to a better understanding of how small open economies can strengthen their transition towards circular economic systems through collaborative resource optimisation.

Keywords: Circular economy, Industrial symbiosis, Quintuple helix model, Systemic readiness

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