# Tangled Threads of Opportunity: A $CO_2$ Valorisation Roadmap for Regional Decarbonisation

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**Development of an Open Innovation Roadmap**: The study created a roadmap that guides Latvian regions in converting $CO_2$ into valuable products, aligning with national and EU sustainability goals.

**Multi-Stakeholder and Multi-Method Approach:** The roadmap integrates co-creative processes, stakeholder collaboration, spatial analysis, performance evaluation, environmental impact assessments, and economic feasibility studies.

**Evaluation of Carbon Valorisation Pathways:** Five $CO_2$ utilisation pathways were assessed, with algal biomass, methanol, and ethanol production emerging as the most sustainable, economically viable, and location-flexible.

**Integrated Governance and Innovation:** The roadmap demonstrates how collaborative governance and cross-sectoral knowledge exchange can drive regional entrepreneurship through innovation clusters and carbon valorisation hubs.

**Theoretical and Practical Contribution:** The model enriches open innovation theory and serves as a practical planning tool for circular economy development and regional decarbonisation.

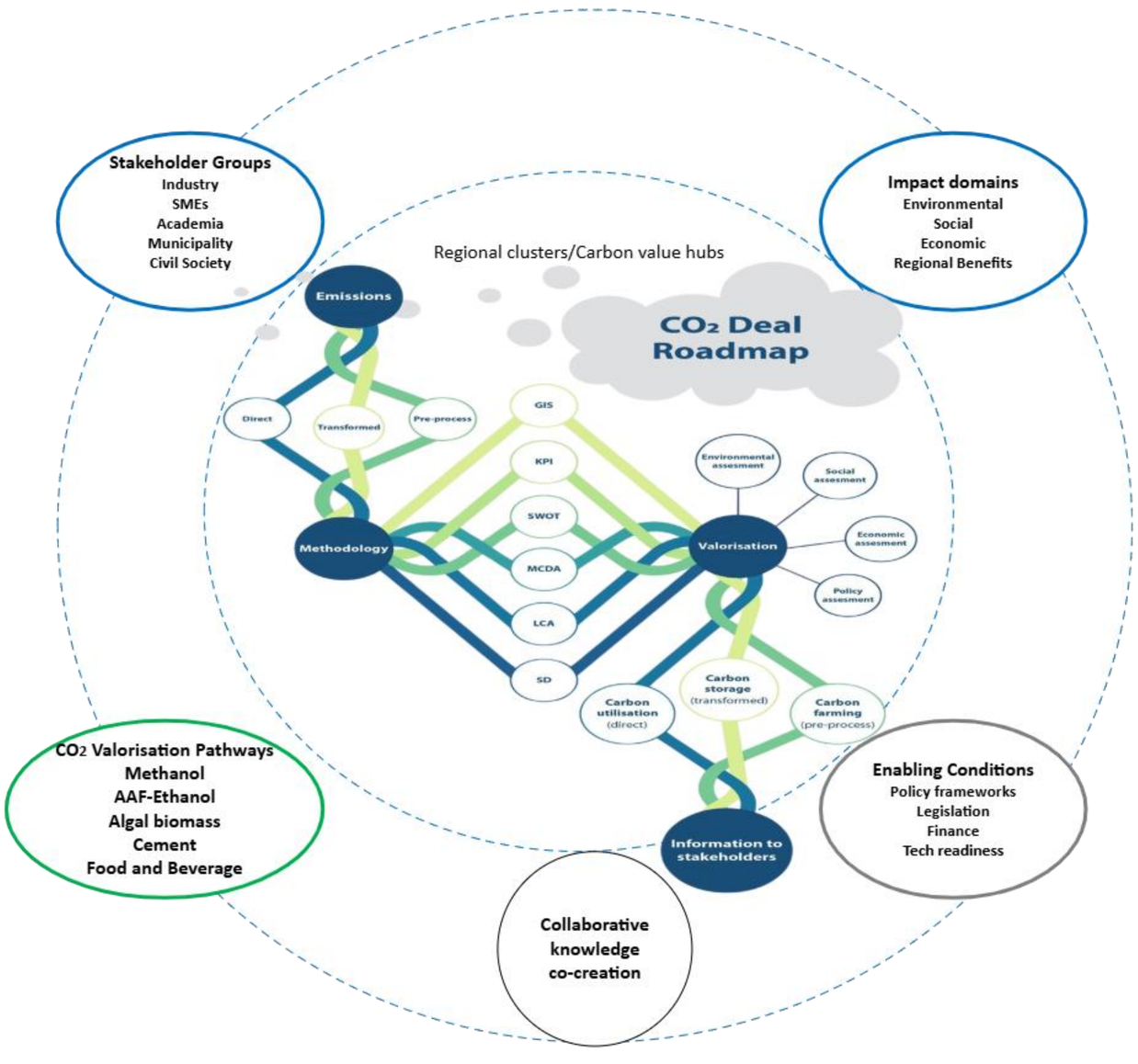
**Scalability and Transferability:** The approach offers a scalable and transferable framework adaptable to other regional contexts and lays the groundwork for future living labs and policy experimentation.

## Introduction

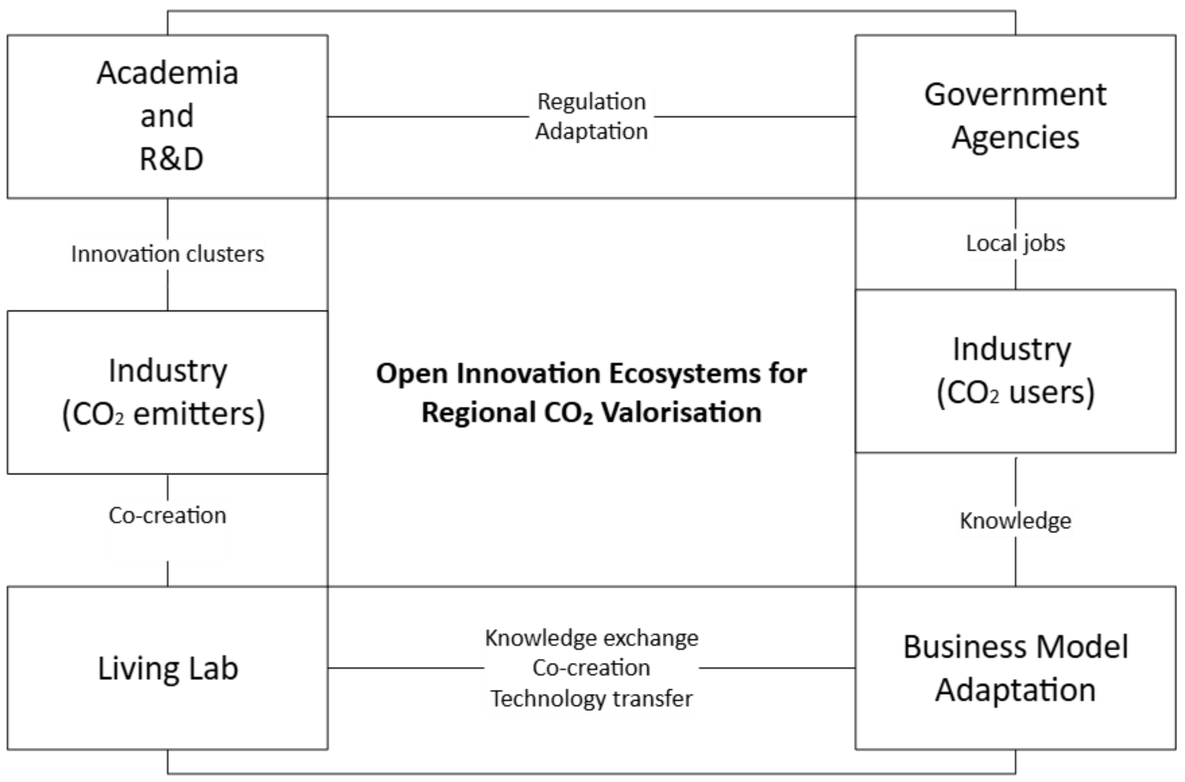
**This study reimagines $CO_2$ as a valuable resource, not waste, using open innovation to unlock its potential for regional sustainability.**

By integrating scientific, industrial, policy, and community perspectives, we developed a dynamic roadmap for Latvia that identifies optimal $CO_2$ valorisation pathways.

Our novel “tangle of threads” approach combines life cycle assessments, economic analysis, and stakeholder input to guide decision-makers in building circular, carbon-smart regions.




**Regional $CO_2$ Valorisation Methodology**




**Open Innovation Ecosystems for Regional $CO_2$ Valorisation**

- ❑ Cross-sector collaboration is essential for effective $CO_2$ valorisation; isolated solutions are insufficient.
- ❑ Open innovation frameworks enable integrated, stakeholder-driven roadmap development.
- ❑ Algal biomass is the most viable pathway, combining sustainability, cost-effectiveness, and deployment flexibility.
- ❑ Innovation clusters build regional capacity, supporting entrepreneurship and infrastructure for $CO_2$ use.
- ❑ Policy alignment and cost-sharing mechanisms are critical for implementation and scalability.
- ❑ The roadmap is transferable, offering a scalable model for circular, low-carbon regional transitions.