



Innovative circular
economy & AI methodology
for sustainable high-energy
performance buildings



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Circularity from the Start: A Strategic Necessity for Industry

Sustainability has become an important part in research and product development. Yet, I believe, as do many others, that one essential question still receives too little attention: ***What happens at the end of a product's life, and how can resources be kept in circulation?*** A product may be energy-efficient, bio-based or associated with lower production emissions, but this does not automatically make it circular. If these questions are addressed only at the product's end-of-life or once product development has been completed, many circular options may no longer be technically or economically feasible.

Circularity must therefore be considered from the outset. This is particularly relevant for construction products, as construction and demolition waste accounts for more than one third of all waste generated in the EU. Insulation materials may remain in buildings for decades and are often connected to other components through adhesives, binders or complex installation systems. Decisions concerning material composition, installation and dismantling can therefore determine whether their value can later be retained or whether they become difficult-to-process construction waste.



Beyond Recyclability



Sustainability and circularity are closely connected, but they address different aspects of product development. Sustainability takes a broad perspective on environmental, economic and social impacts across the life cycle. Circularity focuses on keeping resources, products and materials in use for as long as possible. Circular strategies can support sustainability by reducing resource use and waste, but their benefits should always be assessed from a broader sustainability perspective. In this context, the R-strategies of the circular economy provide a practical framework by prioritising options according to the value they retain. Although many industries still focus mainly on recycling, higher-value strategies such as refusing, rethinking, reusing, repairing and refurbishing should be considered first, whenever they are compatible with environmental and social objectives, technical performance requirements and economic feasibility. In case these options are no longer viable, materials can be recovered and returned to the economy as secondary raw materials.

Against this background, the range of circular strategies available at later stages is largely determined during product development. Circularity must therefore be embedded in the design process from the outset. “Design-for-X” approaches can support repair, lifetime extension and recycling by making products modular, separable and easy to dismantle. For insulation materials, this includes considering whether production residues can be reintegrated, whether materials can be separated from surrounding building components and whether they can be reused or repurposed before recycling is considered. Yet, design alone is not sufficient, especially for products that may remain in use for decades. The information needed to recover their value must also remain accessible. Digital Product Passports, Material Passports and Digital Building Logbooks can document which materials were used, how they were combined and how they may later be separated, reused or recycled. For long-lived buildings, such



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documentation helps ensure that relevant knowledge is still available when renovation, dismantling or end-of-life decisions are made.

The Business Case for Circularity

Keeping materials in circulation can reduce demand for virgin resources, strengthen supply-chain resilience and preserve economic value. These benefits are increasingly relevant for European industries dependent on imported raw materials or energy-intensive production. Regulatory developments and changing customer expectations also make circularity more important for market access and competitiveness. However, circularity will only function at scale if it is supported by a viable business case. A viable business case for circularity starts with identifying where value can be retained and who benefits from it. In practice, companies should therefore assess which R-strategies are technically, economically, socially and environmentally viable, how take-back and implementation will be organised and financed, which partners and infrastructure are needed, what quality requirements retained or recovered materials must meet, and whether there is sufficient market demand. Close cooperation across the value network is essential to align roles, capabilities and incentives. Pilot projects can help test whether the required collection, processing and quality standards are achievable in practice, while real cost, material-flow and environmental- and social-impact data provide the evidence needed before solutions are scaled.

Circularity in SNUG

Within the SNUG project, we integrate circular economy considerations into the development and assessment of innovative insulation materials. Through regular discussions with material developers, construction partners, and circularity experts, we explore how different R-strategies could be applied and where practical challenges may arise. From these exchanges, we have learned that even seemingly small design decisions can have far-reaching consequences.

Adhesives may improve durability but restrict later separation. Material combinations may enhance insulation performance while making dismantling and recycling more difficult. Secondary resources may reduce the need for virgin materials, but they can also require additional quality control. Our experience shows that addressing these trade-offs early does not guarantee a perfectly closed loop. It does, however, help us identify and prevent avoidable barriers before they become embedded in the final product.

From Circular Ambition to Strategic Action

In my view, circularity should not be treated as an afterthought or reduced to a statement about recycling. Rather, it should inform design, material selection, manufacturing processes, partnerships and business model development from the outset. I believe that, for companies seeking to remain competitive, compliant, and adaptable, circularity is increasingly becoming a strategic necessity. Translating this ambition into action requires management commitment, clear responsibilities, and the integration of circularity into concrete design, investment, and partnership decisions. The circular economy begins long before a material becomes waste – it starts with the first design decision and the development of a viable business case.



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Stefanie is a key researcher at Brimatech, specialising in qualitative socio-economic research and innovation uptake. Her work focuses on analysing stakeholder needs and acceptance, and the development of business models and exploitation strategies in the fields of sustainability, the circular economy, and nanotechnology. She also contributes to strategic and policy-oriented advisory activities for government ministries. Moreover, she serves on the board of SusChem-AT, is a member of the ISWA Working Group on Climate Change and Waste Management, and holds a PhD in Natural Resources and Life Sciences.

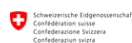
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