

Are Bio-based Insulation Systems in Net-zero Carbon Building Renovations Inherently Circular?

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The UK and Europe have committed to reducing emissions to as close to zero as possible by 2050 to avoid catastrophic climate change. Reaching net zero means tackling all sources of emissions, and heating for homes and workspaces makes up almost a third of all carbon emissions. So, improving the energy efficiency of buildings is a priority, ensuring they require less energy to heat, making them cheaper to run and more comfortable to live in, while reducing our dependence on imported energy. At the same time, governments have fully engaged in transitioning to a circular economy to boost the economy and reduce dependency on raw materials while protecting the environment and accelerating to net zero. However, there is no clarity on the role that net-zero carbon building renovations in construction and operation have in the transition to a circular building environment.

The study consists of practice-oriented case study research aiming at contributing to practitioners' knowledge in the building sector by investigating the level of circularity of bio-based insulation systems applied in net-zero building renovations to define the potential of this intervention in the implementation of a circular built environment. Firstly, an analysis of existing bio-based insulation systems was implemented through a literature review, and a taxonomy of 6 system types was developed and compared in terms of materials, application features, advantages and disadvantages. Secondly, the study analysed existing tools available in the literature to assess the circularity of building components and selected the CBC-generator developed by van Stijn & Gruis (2019) as a design framework suitable for evaluating the circularity of identified insulation systems. Thirdly, the selected method was applied to the analysis of the taxonomy of bio-based insulation systems through case study research to assess their degree of circularity and understand the role played by this type of intervention for net-zero building renovation in the transition to a circular built environment.

The study showed that a limited degree of circularity is achieved by focusing on bio-based insulation materials only. In net-zero carbon building renovations in construction and operation, considerations are limited to carbon emissions associated with the building's production and construction stages up to practical completion of the renovation, and to carbon emissions associated with the building's operational energy used annually. This approach does not consider carbon emissions associated with waste generated by the inefficient maintenance, refurbishment and limited final recovery of building materials and systems applied in net-zero building renovations. Among the 6 types of bio-based insulation systems, the vapour-open internal insulation system resulted in the most circular system because of its whole bio-based nature, combined with only mechanical connections, which facilitate slowing and closing the material loop. Based on findings, recommendations for improving the circularity of bio-based insulation systems were formulated to support the transition to a circular built environment.

Keywords: carbon-neutral renovation, circular building, circular design, circular economy, net-zero carbon building.

Funding and acknowledgements

This work was supported by UKRI AHRC, grant number AH/Y003861/1.

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