CERIS Civil Engineering Research and Innovation for Sustainability

Eco-design for thermal rehabilitation of buildings envelope based on energy, economic and environmental life cycle assessment

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Summary

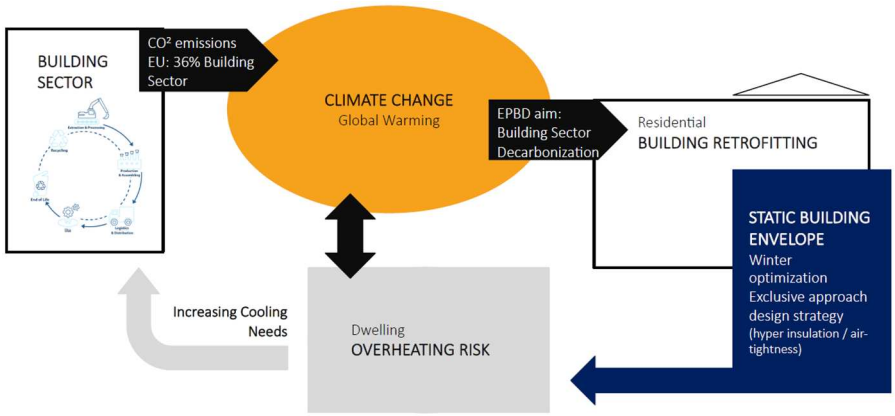
The goal is the eco-design of alternative solutions for the thermal rehabilitation of the buildings envelope to reach high energy performance (NZEB buildings). The study covers the holistic assessment of the most common insulation solutions on walls and roofs prescribed by experts in the scope of the Energy Certification System. A comparative economic, energy and environmental Life-Cycle Assessment (LCA) from cradle to cradle (C2C) between alternative eco-efficient solutions and their raw materials will be built based on site-specific data. The improvement of the energy performance of existing buildings is of major interest to reduce energy consumption and consequent CO_2 emissions. The identification and eco- design of appropriate solutions shall be explored to guarantee the best commitment in terms of energy, cost and environmental performance on the life cycle.

In Portugal, it is already mandatory the energy certification of existing dwelling, which includes the identification of energy improvement measures that can be implemented on the building, along with a simple payback analysis. This analysis in however limited, and the joint consideration of the environmental dimension can support better the decisions of the owner or designer. This corresponds to the eco-design and detailed assessment of the improved energy, economic and environmental performance of these thermal rehabilitation solutions, for the remaining service life of the buildings (30 or 50 years). This thesis will start with the selection and characterization of the most common systems used in Portugal for the external or internal insulation of the building envelope (i.e., external walls and pitched or flat roofs). An experimental and numerical study will support the energy performance characterization of these solutions on building's rehabilitation.

Then, a detailed environmental LCA of the materials used on each solution will be carried on. Site-specific data will be collected from national producers for selected materials (e.g., of insulating mortars with lightweight aggregates, insulating boards, and ETICS and ITICS systems). The LCA data for the remaining materials will be selected from European sources. After completing the LCA at the material level, the C2C economic, energy and environmental performance of these thermal eco-design rehabilitation alternatives will be evaluated. With this aim, case-studies of representative single-family homes will be chosen, and the thermal rehabilitation solutions will be fully characterised. An eco-design approach will be used to optimize the solutions studied, which will also be rated in terms of their contribution to fulfil NZEB requirements. A discussion will be made in terms of the: (i) use of alternative insulation materials and progressive increase of their thickness; (ii) thermal performance of the building components; and (iii) heating and cooling energy – expected and real - needs.

Keywords

Eco-design, thermal rehabilitation, building envelope, NZEB, LCA, C2C.



The problem to be addressed.