

## High-performance sustainable solutions for the refurbishment of commercial buildings

### Summary

Retail stores are amongst the building typologies with the highest carbon and energy intensity, placing this segment in the top 10 most carbon-intensive business sectors. In addition, retail stores are responsible for 9% of the European building stock with an energy intensity that ranges from 500 to 1000 kWh/m<sup>2</sup>/y, i.e. three times that of conventional residential buildings and five times that of office buildings. Furthermore, refrigeration systems in food retailers are particularly carbon intensive in terms of direct and indirect emissions. In terms of indirect greenhouse gas emissions, retailers' carbon intensity in the value chain is even higher – a factor of 7 for its supply chain and a factor of 3 for consumer products' end life. In terms of water resources, water use in the commercial buildings accounts for up to 20% of water withdrawal, whereas the global production of consumer goods is responsible for 80% of all water use, making the direct and indirect water footprint of the retail sector considerably high. Overall, retailers' environmental impact is a substantial problem in terms of the direct effects originated by retail buildings' buildings and operation, but also in terms of the indirect effects originated by the value chain and the production of consumer goods.

The business paradigm shift and increasingly demanding regulation in terms of climate change are pushing retailers into corporate sustainability and energy and carbon efficiency. The current context thus encourages the improvement of retailers' environmental performance in retail buildings. Moreover, retail stores also typically undergo frequent refurbishment cycles, thus increasing the environmental impacts - and opportunities of improvement - in retail buildings. Building sustainability assessment methods can play a significant role in this task. Thus, this Doctoral Thesis study sets out to explore whether: i) commercial buildings have an environmental performance that could be structurally improved either in new projects, in refurbishment processes or during store operation and ii) if yes, define the priority strategies and appropriate times for building intervention. To answer these research questions, the Portuguese system LiderA® for retail buildings was developed, in view of its applicability in different life cycle stages of retail buildings, namely new construction, refurbishment, or building operation.

The development of LiderA® for retail buildings led to the creation of benchmarks for energy, carbon and water intensity that support the assessment of the environmental performance of ii retail buildings during operation, and to the identification of prescriptive solutions that can be implemented to increase sustainability in new buildings and in refurbishment processes. Best practice business operation strategies, extensible to the value chain, were also investigated. The adjusted method LiderA® for retail buildings was tested in two case studies - a food retail store and a non-food retail store - which allowed validating the proposed method. The work developed in this research has confirmed that it is possible to improve the environmental performance of retail buildings in an efficient manner, suggesting areas of improvement, defining thresholds levels for adequate natural resources' consumption, indicating high performance sustainable solutions and sustainable business practices that lead to increase sustainability performance. Limitations and opportunities in this field of research are also addressed in order to be considered and leveraged in future works.

### Keywords

Commercial and retail buildings, Building Sustainability Assessment (BSA) methods, environmental performance, energy and water efficiency, LiderA®.



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