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Adaptive reuse of buildings: Eco-efficiency assessment of retrofit strategies for alternative uses of an historic building

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1 **Adaptive reuse of buildings: eco-efficiency assessment of retrofit strategies for alternative uses**
2 **of an historic building**

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8 **Abstract**

9 Adaptive reuse is a process of retrofitting old buildings for new uses. Existing residential buildings in
10 European cities are often being retrofitted to be adapted as office buildings whilst keeping its historical value.
11 The main goal of this article is to perform an eco-efficiency assessment for an historic building to assess
12 alternative retrofit strategies and uses, including investigate how occupancy influences the economic and
13 environmental life-cycle performance of retrofit strategies. A life-cycle model was implemented to a single-
14 family house from the beginning of the 20th century retrofitted to be used as an office building. Nine
15 occupancy scenarios combined with alternative insulation levels were defined. The occupancy scenarios are
16 defined by level of occupancy (office use, and low and high residential occupancy) and set-points (18°C, 20°C
17 and 22°C for heating combined with 23°C, 25°C and 27°C for cooling). The insulation levels comprise
18 alternative roof insulation levels (0, 40, 80 and 120 mm) and exterior-wall inside insulation levels (0, 40 and
19 80 mm). Eco-efficiency assessment shows that higher comfort conditions result in better eco-efficient results
20 in all types of occupancy. Retrofit strategies with more than 80 mm of roof insulation are not eco-efficient. In
21 summary, different retrofit strategies should be adopted to maximize savings and minimize environmental
22 impacts depending on the type of use and occupancy level. Therefore, it is crucial to take into account both the
23 economic and environmental perspective to support a comprehensive retrofit decision process.

24 **Keywords:** Building retrofits, Environmental impacts, Life-cycle assessment, Life-cycle cost assessment,
25 Occupancy pattern, Thermal insulation

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