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Environmental assessment of deep energy refurbishment for energy efficiency- case study of an office building in New Zealand

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Abstract: The purpose of this study was to determine the environmental impacts associated with a deep energy efficiency refurbishment using life cycle assessment. A prototypical refurbished model of an office building located in Auckland, New Zealand was used as a case study. The refurbishment included major changes to the building envelope with additional insulation, modified wall-window ratio, solar shading as well as technical replacement of the lighting and HVAC system. The study included identification of environmental hot spots of a deep energy refurbishment, and consideration of the effect of different electricity mixes in New Zealand on the total environmental impact of the refurbished building when compared to the un-refurbished existing building over different operation periods. An environmental payback period was calculated for each impact category. The results of this study indicate that deep energy refurbishment is associated with significant environmental impacts mainly due to the use of energy-intensive construction materials. However, the refurbishment yields net reductions in most impact categories if the building has a longer operational period. The environmental impacts of a building's operation are mainly associated New Zealand's electricity generated from coal. As future scenarios of New Zealand's electricity mix have a reduced share of electricity generated from coal, the environmental benefits of avoided electricity consumption are also reduced. The study concludes that measures to promote energy efficiency refurbishment in office buildings where a significant proportion of the operational energy is provided from renewable energy sources, should be carefully considered because they may not reduce overall environmental impacts.

Keywords: refurbishment, energy efficiency, office building, life cycle assessment, electricity grid mix, environmental payback

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