

## Evaluating retrofit option for building with the lowest energy performance:

Energy use, profitability, environmental impact, and thermal comfort

Many buildings in Europe and Sweden currently have low energy performance and need retrofitting to become more efficient. To boost energy efficiency and support sustainable development, targets have been set by both the European Union and Sweden to improve the energy performance of buildings and reduce their environmental impact. One way to achieve these goals is to retrofit the existing buildings, but how should the best retrofitting measures be chosen?

This study seeks to find an answer to the question by evaluating how different retrofitting options affect the energy use, profitability, environmental impact, and thermal comfort of a building. It aims to find the most effective measures by analyzing their performance across each of these categories. The findings of this study reveal that the best-performing retrofitting options vary depending on the building's characteristics and the specific focus of the analysis. The study also provides valuable insights on how prioritizing one aspect can lead to negative implications on the other analysis factors and therefore, emphasizes the importance of finding a balance between, energy efficiency, cost, environmental impact, and comfort to achieve the best overall results.

This study focused on two multifamily buildings with the most common characteristics in Skåne, Sweden, chosen from a database of buildings with the lowest energy performance. 560 different retrofitting options were evaluated for each building, such as adding insulation to the roof and façade, installing new windows, and implementing a mechanical ventilation system with heat recovery and heat pump system.

The results of this study indicate that the best energy savings and lowest environmental impact can be achieved by combining all the retrofitting measures to reduce the operational energy and its impact. The most cost-effective retrofitting options consisted of façade and roof insulation, providing significant energy savings for a relatively low investment cost. The best thermal comfort was achieved by the implementation of a mechanical ventilation system with window replacements or roof insulation.

In summary, this study provides valuable information about retrofitting existing buildings to enhance the energy-savings, improve cost-effectiveness, provide good comfort for occupants, and contribute to a sustainable future.