A Profit-Making Combination of Energy-Efficient Building Retrofitting Techniques

POPULAR SUMMARY
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Building energy constitutes over staggeringly 40% of the energy use in the European Union. To cope with it, improving the building envelope of an existing building has been widely known to lower the heating energy usage. It was found in this study that, when it is combined with the utilization of a heat pump system, it performs better both in terms of energy saving and money saving.

The Problem

When we want to choose the best renovation technique for a certain building, two questions firstly come to mind. *Which renovation will lower the energy use the most?* and *Which retrofitting technique will be the most beneficial in a certain period of time?* Well, the answer depends on so many factors, such as energy-efficient strategy chosen, economic condition, prices, and labors. Besides, the period of the assessment is a determining frame to see the most economically beneficial renovation.

The Method

Initially, the information of the existing building, such as the heating energy use, the construction of the building envelope, the way of how the ventilation system works, and the drawings, were collected and assessed. After reviewing some literature on renovation techniques, a set of possible renovations was designed and studied further. It comprises of adding insulation onto the existing walls and replacing old windows with triple-pane windows, utilization of exhaust-air heat pump system (EAHP), application of ground-source heat pump system (GSHP), and implementation of individual district heating substations. An in-depth assessment that involves heating energy simulation, energy supply calculation, and economic analysis was then conducted. In the end, the best renovation technique in terms of energy saving was chosen. As for the economic analysis, two renovations were found to be the most beneficial in the 35-year period and 50-year period of analysis.

The Result

As expected, renovating the building envelope performed well in saving the heating energy demand in this project. The figure decreased to more than 60% of the initial one. As when the heat pump systems were applied, the heating energy demand of the building remained the same as before. However, the energy used to supply the demanded heating energy was lower. This is due to the fact that the heat pump systems consumed lower electricity energy compared to the heating energy that they supplied. To be clear, a heat pump system that has a COP of 3.6 requires 1 kWh of electricity to provide 3.6 kWh of heating energy. Thus, the combination of the renovation of the building envelope and the implementation of the EAHP system performed the best in terms of energy saving by lowering not only the heating energy demand but also the energy required to supply the heating energy demand. Surprisingly, the EAHP coverage increase from 50% to around 90% when the building envelope was also renovated. As for the implementation of the individual district heating substations, it was found to cut the heating energy loss through the underground piping system of the cluster. However, it is worth to mention that the heat loss was not eliminated but relocated to the energy company's side instead.

It was proved that the most beneficial renovation case depended on the period that we chose for the economic analysis. In this project, the most profit-making renovations are the implementation of the GSHP system and the combination of improving the building envelope and the usage of exhaust-air heat pumps for the 35-year period and 50-year period respectively. Surprisingly, when the EAHP was combined with the renovation of the building envelope, the increment of the initial renovation expenses was insignificant compared to the saving on the annual expenses.

The Conclusion

The combination of improving the building envelope and using the EAHP as the supply system has been proved to be the best both in terms of energy saving and money saving in the 50-year period. However, it should be noted that it depends on the economic parameters and the prices of the energy and the renovation. Moreover, the most beneficial renovation for a shorter and longer period than the 50-year period might be different.