Building Energy Efficiency: A Race Against Climate Change

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As the world's largest energy consumer, buildings account for 38 % of both total energy consumption and CO_2 emissions. Although there has been an acceleration in sustainable technologies invested in buildings, the energy demand rose by almost 17 % between 2010 and 2021. The International Energy Agency has deemed the building sector "not on track" to eliminate emissions by 2050. The situation is dire, and there is an evident need for change.

In Sweden, buildings account for 34 % of consumed energy and 21 % of the total CO_2 emissions. The Paris Agreement commits us to prevent global temperature rises greater than 2 ° C and to prevent a rise greater than 1.5 ° C. A sustainable future requires significant efforts.

The energy class of a building is a classification dependent on energy consumption. The classification system ranges between A (low consumption) to G (high consumption), and more than 60 % of commercial premises in Sweden have a grade of E or worse. Most of these were erected between 1960 and 1989. Throughout Europe, it is predicted that 50 % of buildings erected before 1975 will exist in 2050.

The EU taxonomy is a classification system created to help define what activities can be justified based on sustainability. In the real estate sector, the taxonomy applies to new constructions, renovations, and acquisition of existing buildings. The taxonomy has led to the development of prohibitions in countries throughout Europe. In the Netherlands, office buildings with an energy class worse than C are prohibited from being let as of 2023. There are no such disallowing of buildings in Sweden, but it will likely emerge.

Implementing retrofit measures in buildings is a way of working with existing buildings to reduce energy consumption. Examples of these are additional insulation, change of lightning systems or windows, or adopting building management systems to adjust energy consumption to the actual usage of the building. Retrofits are important as refurbishing and reusing existing buildings is often more sustainable than demolishing and constructing new ones.

We conducted a case study of an office building in Malmö, Sweden, examining various retrofit measures, their potential impact on the building's energy performance, and whether it is economically viable. The building was erected in 1967 and currently has the energy class F. The study used the energy simulation program IDA ICE. Information about the building was gathered from blueprints, inquiries with the owner, and template data where information was missing. The costs of these retrofits were gathered from an encyclopedia of maintenance costs.

There were 9 retrofit measures implemented, spread across exterior walls, roof, windows, and the heating, ventilation, and air conditioning (HVAC) system. Adopted measures consisted of additional insulation to the roof and walls, changing windows, and changing the HVAC system. These formed 24 possible combinations and energy simulations. The results showed significant reductions in energy consumption, ranging between 64.28 and 79.64 %. However, adding the economic aspect, only 12 simulations resulted in a positive net present value (NPV) for a given energy price and discount rate. The simulations with positive NPV yielded a consumption corresponding to energy classes B, C, and D (from class F).

While it was found that it is possible to enhance energy consumption, not all retrofits contributed equally. Neither were all of them deemed to be economically justified. Windows has a considerable cost in relation to the energy saved. Additional insulation was deemed only a viable option up to a certain level. The HVAC system proved to have the most significant impact on consumed energy, where combinations with a system where airflow adjusted to occupancy resulted in the lowest energy consumption.

Moreover, two limits were found, one for each HVAC system, to which the total energy consumption converged as investment costs increased. Reducing consumption below these limits would probably be expensive, which is an intriguing observation, considering the building's current energy class. Enhancing the energy efficiency in buildings with higher energy classes may thus prove more challenging.

The study is interesting as it demonstrates the feasibility of implementing energy-efficient measures that are also economically viable. Furthermore, whether a positive NPV should be the dominant measure concerning green investments is worth questioning. One could equate green investments with a green premium to ensure future cash flows; not carrying out the retrofits could, inversely, be a brown penalty. Failing to undertake actions may also penalize building owners if poor-performing buildings were to be prohibited from being let, as shown in the Netherlands.