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Viewpoint

Economic analysis of passive houses and low-energy houses compared with standard houses

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Abstract

As the energy demand used for space heating accounts for 78% of EU15 household delivered energy consumption, significant reductions in energy demand can be achieved by promoting low-energy buildings. Our study investigates three building types: the standard house, the low-energy house and the passive house. As more far-reaching measures concerning energy savings usually lead to higher investments, the aim of our study is to perform an economic analysis in order to determine the economic viability of the three building types.

Keywords: Passive house; Low-energy house; Cost–benefit analysis

1. Introduction

The actual debate on global warming cranks up the search for environment-friendly alternatives to maintain our current living standards and level of activity. The issue is increasingly being addressed on a global level, a condition sine qua non to achieve results. The main step is the Kyoto Protocol, as amendment on the International Treaty on Climate Change, which aims at reducing the emission of greenhouse gases (GHGs) by 5% under the 1990 level by 2012.

The European debate has been concentrated on the contribution by different stakeholders in the environmental issue. As Fig. 1 illustrates, public electricity and heat production accounts for 30% of GHG emissions (EEA, 2007). Logically, most reductions can be realised in this sector. Different technologies have been and still are under investigation and development, such as solar, wind, biomass or tidal energy. These green energy sources should permit to reduce GHG emission while safeguarding energy production and thus our current living standard and level of activity.

As can be seen in Fig. 1 and according to Schnieders and Hermelink (2006), houses provide an important possibility to build on our way towards sustainable living standards, especially concerning energy. This fourth significant source of GHG emissions concerns the residential and commercial (including institutional) sector, which accounts for 17% of all emissions (EEA, 2007). The large and merely untapped savings potential currently gains more attention, both in the research world and amongst the general public.

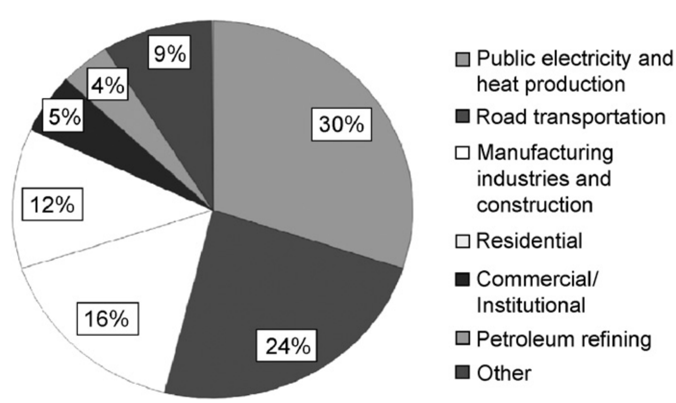

Fig. 1. Sources of greenhouse gas emissions in CO_2 equivalent (Tg) in the EU-15 (2005). *Reference*: European Environmental Agency (2007).

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Governments elaborate support mechanisms to stimulate energy efficiency in existing and new buildings. The potential GHG emission reduction in the housing sector will be addressed in this paper from an economic point of view.

As the energy demand used for space heating accounts for 78% of EU15 household delivered energy consumption (Eurostat, 1999), significant reductions in energy demand can be achieved by promoting low-energy buildings (Feist et al., 2005). This currently largely untapped potential offers significant opportunities to reach the Kyoto objectives (Jakob, 2006).

In their article, Schnieders and Hermelink (2006) suggest that passive houses offer a viable option to meet the remaining energy demand only with renewable sources, within the boundaries of availability of renewable energy and affordability. However, our analysis questions the economic viability of passive houses. Therefore, an economic analysis will be carried out, in order to compare the potential of standard houses, low-energy houses and passive houses from an economic investment point of view.

2. Main concepts

The Belgian government has laid the responsibility for energy policies of buildings with the different regions (Flanders, the Walloon region and Brussels). Only in the Flemish region, legislation is currently operational through the EPB legislation (Dutch abbreviation for Energy Performance Interior Climate). These rules apply to all construction works (whether new development or renovation) for which urban development permits are required. The EPB legislation only concerns buildings with cooling and/or heating systems, aiming at creating a specific interior climate for people. As different requirements apply to new development and renovation, only the former will be discussed within the framework of this article.

Prior Flemish legislation in this matter contained only obligations concerning the K-value, which is an indicator for the degree of thermal losses through the buildings' shell (similar to the overall heat transfer coefficient U, which applies to simple materials, while the K-value is used for compound materials (Appendix B); expressed in W/m^2K). However, this early legislation was not controlled for compliance and infringements remained unpunished. The new EPB legislation imposed additional requirements: a stricter K-value, a maximal E-value (a measure for energy consumption of a building compared with a reference value (Appendix A)) and minimal ventilation requirements. In the meantime, the Flemish government has taken measures to solve the non-compliance issue. In a central electronic database, a number of documents concerning the building should be uploaded, thereby enabling efficient and precise controls. Additionally, the sanction has been altered from a summons to an administrative fine. Both legislations, the old one dating from 1991 and the new EPB, are compared in Table 1.

Table 1
Comparison of two energy-saving legislations

Legislation 18/09/1991	EPB legislation
K55	K45 $E \leqslant 100$ Controlled ventilation flow $\geqslant 30\,m^3/h$ per person

Table 2
Key values under EPB legislation

Type	Building requirements
Standard building	$\leqslant$K45 $E \leqslant 100$ Controlled ventilation flow $\geqslant 30\,m^3/h$ per person
Low-energy building	K30–K45 Yearly energy need for heating purposes $\leqslant 30\,kWh/m^2$ Controlled ventilation flow $\geqslant 30\,m^3/h$ per person
Passive house	K15–K20 Yearly energy need for heating purposes $\leqslant 15\,kWh/m^2$ Primary energy need $\leqslant 120\,kWh/m^2$ Controlled ventilation flow $\geqslant 30\,m^3/h$ per person

In order to facilitate controls and preceding calculations, EPB software has been developed, which enables architects and controlling authorities to compute the E-value and the corresponding energy need, according to the specific characteristics of a building. The key values under EPB legislation are presented in Table 2, as they will be used throughout the analysis.

As stated previously, the residential and commercial sector offers substantial potential in the struggle to reduce GHG emissions. Often, three types of buildings are currently under investigation: the standard building, the low-energy building and the passive house. These main concepts are delineated according to the definitions presented by Sartori and Hestnes (2007, p. 249) and Badescu and Sicre (2003, p. 1077):

- *Conventional building* or *standard building*: Refers to a building built according to the common practice of a specific country in a specific period, meeting the minimal legally required energy standards.
- *Low-energy building*: Refers to a building built according to special design criteria aimed at minimising the building's operating energy.
- *Passive house*: A type of low-energy building; design is oriented to make maximum exploitation of passive technologies (eventually adopting also some active solar technology), assuring a comfortable indoor climate during summer and winter without needing any conventional heating or cooling system.