European Commission

Science for Environment Policy

The significance of embodied carbon and energy in house construction

Although most energy in homes is used for heating and hot water, significant amounts of energy are also used when a house is built. A lifecycle assessment of a low-energy, affordable timber house indicates that large energy and carbon savings can be made when alternatives to traditional methods of construction are used.

As almost a quarter of all global CO_2 emissions are attributed to energy use in buildings, reducing the energy demand and carbon emissions linked to buildings is an important goal for government climate policy. However, the energy used, and associated carbon emissions, when a house is built is often overlooked and mainly comes from the extraction, processing, manufacture, transportation and use of materials for construction. This energy and carbon is thus considered to be hidden or 'embodied' in the house.

The researchers assessed the energy used and carbon emitted in the construction of a novel low-energy house in the UK using a life cycle method. The house was a three-bedroom semi-detached house made with a factory-built, foam insulated, timber frame and assembled in modules at the building site, where it was clad with larch planks. It was compared with two similar buildings constructed using more traditional methods: a timber-framed house with brick cladding and a house built with traditional masonry techniques (block internal walls, insulated cavity walls and brick cladding).

The assessment, based on data from an inventory of all the materials and fossil fuels used during construction, revealed that the low-energy house required a total of 519GJ (gigajoules) of primary energy to build (5.7 GJ/m^2), embodying 35 tonnes of CO_2 (405 kilograms of CO_2 per square metre). 82% of the energy was used in preparing the materials (over a third of this from concrete) and the rest was used to transport materials, remove waste and for onsite energy requirements.

The brick-clad house embodied over 30% more carbon and energy, owing to the increase in minerals associated with the cladding (sand, brick and cement) and increases in transport and construction costs. The masonry house embodied 51% more carbon and 35% more energy compared to the timber framed, larch-clad house.

Most energy and carbon savings in the low-energy house came from the use of wood as an alternative to cement, bricks and steel; larch cladding produces an energy saving of 24% compared to bricks. Less structural support is also needed, further reducing the need for energy rich materials, such as steel and concrete. The offsite, factory manufacturing of the timber fames also reduced energy costs.

Addressing the alternative methods of construction outlined in this study could be a valuable contribution to national carbon reduction efforts. Further energy savings from construction include reducing onsite waste production, which accounts 14% of total embodied carbon, and reducing the amount of cement used, by replacing with ground granulated blast furnace slag, fly ash or other lower carbon alternatives.

Issue 38
Green Construction

Source: Monahan, J., Powell, J.C. (2011) An embodied carbon and energy analysis of modern methods of construction in housing: A case study using a lifecycle assessment framework. *Energy and Buildings* 43: 179-188. DOI: 10.1016/j.enbuild.2010.09.005

Contact:
j.monahan@uea.ac.uk

Read more about:
Climate change and energy, Sustainable consumption and production