European Commission

Science for Environment Policy

Green buildings: researchers call for fuller environmental assessment

Over half of a low-energy building's environmental impact occurred before it was even occupied, a new case study from Italy calculates. The researchers recommend expanding the environmental assessment of buildings from just the operational stage of a building's life, when it is in use, to include production and transport of materials, construction activities and building maintenance. A wide range of environmental impacts should also be considered, they argue, and not just energy use.

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Source: Paleari, M., Lavagna, M. & Campioli, A. (2016). The assessment of the relevance of building components and life phases for the environmental profile of nearly zero-energy buildings: life cycle assessment of a multifamily building in Italy. *The International Journal of Life Cycle Assessment*, 1–24. DOI: 10.1007/s11367-016-1133-6.

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Buildings are the biggest consumer of energy in Europe; in 2010 it was estimated that the building sector, considered as an end-user, accounts for 42% of energy consumption in EU countries — this compares with 32% for transport and 24% for industry. For this reason, the EU has pushed for greater energy efficiency of buildings and the Energy Performance of Buildings Directive[1] calls for all new buildings to be 'nearly zero energy' by the end of 2020. A nearly zero-energy building is defined by this Directive as a building that has very high energy performance, and that the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources. The energy performance of a building is the energy demand associated with the typical use of the building, which includes energy used for heating, cooling, hot-water production, mechanical ventilation and lighting.

This study considers how the environmental performance of buildings could be improved further through assessment procedures which go beyond measuring energy consumption for the typical use of the building, as required by the Directive.

The total energy of a very efficient building when in use and over its lifetime could be around 20% to 30% less than a conventional building, taking into account a strong reduction in heating requirements and the efficiency of domestic hot-water and electrical systems. The behaviour of the residents of very efficient buildings is also influenced towards energy efficiency more so than in traditional buildings. Despite this, they may not be as low-energy as they first appear. This is mainly because designers typically achieve low-energy status by using high-performance materials for the exterior (e.g. walls, roof, windows) and technical systems for onsite energy production and efficiency (e.g. solar panels), which need energy to be manufactured, i.e. low-energy buildings typically have more 'embodied energy' than conventional buildings because they consume much less energy in the in-use phase of the building. Assessments which only focus on the in-use phase miss these pre-use impacts.

The researchers explored a greater range of the environmental impacts of buildings through a detailed life-cycle assessment of a new residential complex, consisting of four blocks of flats, near Milan. This is classified as a near-zero-energy building project and has onsite renewable sources of energy and heat (PV panels and a borehole heat exchanger, which captures heat from the ground).

The assessment included all stages of the complex's life: production and transport of materials and components, building-site activities, materials for maintenance and their transport and end-of-life. It measured potential environmental impacts on: consumption of fossil fuels, global warming, ozone layer depletion, photochemical oxidation (smog), acidification and eutrophication. Data for the assessment came from many sources: the environmental data are from the Ecoinvent database (although it should be noted that this has limited data on building construction materials, and these mostly come from a single manufacturer in a specific country); the building data are from construction company's invoices, building-site reports, construction-project drawings and product datasheets.

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1. Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

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Results revealed that 56% of the complex's total environmental impact occurred during the pre-use phase, which includes materials' production, their transport to the building site and construction activities. The operational stage accounted for 31% of the total impact. Thus, an operation-focused assessment would have only revealed a third of this complex's total impact.

Maintenance (also counted as part of the use stage) of the buildings assessed, accounted for around 10% of the total impact. This was calculated in terms of production, transport, installation of replacement parts and components, and the removal and disposal of old components.

Total fossil-fuel consumption after 100 years of life was estimated to be 193 950 gigajoules (GJ), equivalent to 133.5 kilowatt hours per square metre per year (kWh/m^{2}y) of floor space. The operational phase accounted for 36% of this: 69 300 GJ, equivalent to 47.7 kWh/m^{2}y. This study considered a 100-year lifespan as appropriate for Italy and this type of building; however, most studies set a building's lifespan at 50 years; in these cases, the operational phase would account for an even lower percentage of a building's energy consumption.

The study concludes that life-cycle analysis provides a useful tool to identify solutions that ensure the lowest overall environmental impact of a building by helping designers find the best balance of energy requirements between pre-use (e.g. materials production) and operational stages. It can also help designers to compare impacts of, and options for, different components and guide their choices towards options that are low in overall environmental impact, and not just energy use; for example, building components with low production impacts or with a longer lifespan.

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