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Setting the carbon footprint criteria for public construction projects

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Abstract

This paper describes a method for controlling the growth of the carbon footprint of buildings during the preparation, design and procurement stages of construction projects. The process utilizes prevailing cost estimation techniques. As an outcome, new indicators for *carbon efficiency* and *carbon economy* of buildings are proposed. They have been developed together with the city of Espoo in a research project that included carbon footprinting of existing buildings and arranging an architectural competition for a low-carbon public building. Both carbon efficiency and economy seem to offer flexible opportunities for an integrated comparison of the environmental and economic sustainability of buildings.

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Keywords: Carbon footprint; carbon efficiency; carbon economy; public buildings; design; procurement; cost estimation

1. Introduction

1.1. The relevance of carbon footprinting of public buildings

The Nordic Built Charter (2012) - signed by more than 120 cities, companies and organizations - states 10 principles for the future built environment. Among these is "zero carbon emissions over the full lifecycle" of a building. Indeed, drastic reductions in anthropogenic greenhouse gas (GHG) emissions are required if we wish to avoid the severe risks (Hansen et al. 2013) that may follow anthropogenic climate change.

As we move towards nearly zero energy buildings, nZEBs (European Parliament, 2010), we need to widen our perspective from the emissions of operational energy use. After all, new buildings will reach nZEB class by 2020; the dominance of emissions seems to change. The relative dominance of the use phase - lifecycle module B6

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according to standard EN15643-2 (CEN, 2011) - of the building seems to decrease and the impact from the material production phase (lifecycle modules A1-3) seems to increase (Hafner et al. 2013). This trend is reinforced by the decreasing carbon intensity of energy (IPCC, 2014), although some studies have found that the decarbonization of energy may slow down in the future (IEA, 2014).

Material selection may change the carbon footprint of energy efficient buildings considerably (Kuittinen, 2013). It has also been found that alternative construction materials may lead into greatly differing weights of building parts thus influencing the emissions of the complete building (Pasanen, 2011). Thus there is a growing need for developing methods for estimating and managing the accumulation of carbon footprint throughout the full lifecycle of the building.

1.2. New approaches needed

In design work, there will likely be needs for estimating the dominance of emissions associated with the lifecycle stages of a building, especially in the production and operation phases. The design process of a building today can benefit from energy simulation tools that allow the architect to simulate how iterative changes affect the energy performance of a building. A similarly practical and widespread method is not, however, used for tracking the carbon footprint of construction products. Several BIM-based (VTT, 2013; Liukka 2014) and standalone (VTT 2013, Finnish Environment Institute 2013, Bionova 2014) estimation tools have been developed, but they have failed to gaining wider use. This is partly due to the legal need to calculate the energy certificate for buildings (Ministry of the Environment 2013) while no requirement for calculating the carbon footprint exists.

Yet, environmental assessment interventions may have considerable impact on the carbon footprint of a building. For instance, the design of the new office for WWF in Woking, UK, included environmental assessment for minimizing the GHG emissions. Lowenstein (2014) found that during and after the design phases the carbon footprint of the building could be reduced from 16.510 to 10.920 t CO_2e. This improvement was the result of comprehensive lifecycle assessment and iterative comparison of alternative technical solutions.

From an economic perspective there exists the need for optimizing the payback times of investments that are needed for nZEB´s both in terms of money and GHG emissions. For example, Becchio et al. (2014) found out that the global cost of nZEB solutions is still (in 2014) from 212 to 313 €/m^2 more expensive than standard solutions. Liu et al. (2014) discovered that if only incremental economic benefits of energy efficiency applications are observed, sustainable buildings seem to have poor potential for market investments. However, it will be considerably more expensive to postpone the mitigation of climate change than to take action now (World Bank, 2012).

1.3. Green public procurement yet to reach its potential

The revision of the EU´s procurement directive (European Parliament, 2014) aims at “facilitating a better integration of environmental considerations in procurement procedures” (European Commission, 2014). Based on the revision of the directive, public purchasers can now decide to choose the product or service based solely on its environmental performance. Therefore the public procurement of construction products requires reliable and transparent practices for rewarding the least harmful environmental impact of the purchased product or service.

However, difficulties have been reported in the recent implementation of green public procurement (GPP) criteria. For example, Alhola (2012) discovered that Finnish public procurers have not known how stringent environmental criteria can be demanded and therefore the criteria have been set low. Sporrong and Bröchner (2009) found out that only 30% of Swedish municipalities used environmental awarding criteria when purchasing design services. Of them, almost 40% reported difficulties in the awarding of the environmental criteria of design services. To unleash the potential of the revised directive, procurers need practical instruction for setting the GPP criteria of building products and design services.

Life cycle assessment (LCA) has been proposed as the most comprehensive means for environmental awarding of different products in GPP (European Commission, 2014b). However, this may, in many cases, require an external