

POLITECNICO DI TORINO
Master of Science in Sustainable Architecture
Honors theses

“Operating Energy” vs “Embodied Energy”: a comparison among methods and building systems

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The responsibility by building industry in terms of energy use, energy resources consumption and, as a result, environmental alterations is a true and an awareness. The aim of the current set of rules is decrease the energy demand, considering the only use stage of buildings, without considering the other energy inputs from building construction process; nevertheless, build means consume energy and create effects on the territory not only during the use phase of the building, but also in the course of the building process, from the extraction of resources to disposal.

This paper focuses on this conviction: the importance to value energy and environmental impact of building, considering the most significant stages of its **life cycle**.

The case study is a house with a wood structure, located in Rosta (TO); the proposal is study the ratio between the most important energy shares in energy balance of a building, considering a life cycle of **50** years: *Operating Energy* (OE) and *Embodied Energy* (EE).

OE concerns especially to the use stage of the building, during which maintain the right conditions of the inside environment by heating, cooling, ventilation, hot water, lighting, etc.

The EE is the energy consumed by all processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery. Nevertheless, in this paper only manufacturing is considered to value the EE, because the quantification and the analysis are too intricate and there is a big difficulty to find all data. This approach ignores some important aspects such as transport, end of life disposal and maintenance, which could have a potentially high impact.

The methodology is based to the current regulations UNI/TS 11300 (Part 1,2 and 4) to value the OE; the calculation of EE is based to UNI 11277 (*Sustainability in construction*). In both cases, the evaluation is based on the elaboration of calculation Excel files.

Non-renewable primary energy is the indicator for annual energy use in operation and for EE; all data are normalized into **kWh/m²-year** (kWh of primary energy per square meters and year of service life). 50 years is considered a typical value for the service life of building before they undertake major renovations in most studies.

The energy evaluation is concentrated on three scenarios:

1. building, just as it, with a wood structure;
2. building, with proposals of modification to reduce both EE and OE; the variations involve both building-heating system and nature of each material of building systems;
3. the house, built with a standard construction system, in brickwork, with cladding wall.

The results show that the proportion of OE is greater than EE, so it is the most important in the energy balance of a building. The EE in the overall energy balance, however, it can't be ignored.

EE should be taken into account in the assessment of energy regulations: is necessary a standard rating method to value the EE, as exists for the evaluation of OE. The aim is define the energy impact of buildings, evaluating the energy efficiency in a life cycle perspective.

At the moment, the major barrier for the inclusion of EE within building performance assessment methods has traditionally been the complexity of the data collection and calculations. Some aspects aren't clear, such as years of life cycle, surface for the normalization of data and different value of EE for products and systems compiled by different databases.

The interest in EE has an impact on design approach; this methodology has the potential to make clearly visible the true environmental impact of design decisions over the full life cycle of a building, naturally promoting long-term best management of energy resources. So the constructive approach can and should be directed towards limiting energy consumption and environmental protection.

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