

POLITECNICO DI TORINO  
SECOND SCHOOL OF ARCHITECTURE  
Master of Science in Architecture  
***Honors theses***

---

**Operating Energy and Embodied Energy comparison: case study of medium size residential building**

by Veronica Valentini

Tutor: Valentina Serra

Co-tutor: Roberto Giordano

In the construction industry, not only the use phase is a source of environmental concern, but also the whole life cycle.

The total life cycle energy of a building therefore includes both Operating Energy (OE) that concerns especially to the use phase and Embodied Energy (EE) that concerns the energy required to operate the process of production of construction materials.

The proposal of this graduation thesis in Architecture, is to study the relative importance between Operating Energy and Embodied Energy in the life cycle of a residential building in Trofarello (TO), that is composing by high volumes of three to six storeys, an underground garage and it covers a floor area of 2112 m<sup>2</sup> with a life cycle of 70 years.

Energy analysis assessed primary energy needs using the program derived from the UNI-TS 11300-1 and the Primary Energy Content on the basis of the UNI 11277.

Were examined two types of construction systems, dry and traditional, of which three different packages walls: a dry assembled wall system, a building system with cladding wall and a building system with rainscreen cladding wall, in both cases the latter two types of bearing structure is made of reinforced concrete.

For both evaluations, the three packages walls were treated with different thickness or type of insulation achieving two values of transmittance of Up wall, a lower one ( $U_p = 0.16 \text{ W / m}^2 \text{ K}$ ) and a higher one ( $U_p = 0.27 \text{ W / m}^2 \text{ K}$ ).

The building, in different constructive solutions was assessed by exposure to North-South and East-West exposure and for both, the assessment of the energy requirements considered three possible relations of the percentage of windows areas: the first percentage satisfies the ratio area-illuminating of 1/8, thus covering 16% of matte surface, a second ratio is 30% and a final is 50%.

Concerning the calculation of the PEC, has been calculated the primary energy content of the individual technical elements that make up the building on the basis of the UNI 8290-1:1981 and more specifically, this value has been calculated for the individual materials of the package wall. The value of PEC can be provided in m<sup>2</sup> and in the total area of building systems and takes into account the portion derived from renewable sources (PECFR) and non-renewable (PEC).

The value of PEC (kW/m<sup>2</sup>) of each material multiplied by the surface of the building system gave a value of PEC of total building system.

The sum of the values of PEC from both renewable and not renewable sources, allow a PEC value of total building.

OE and EE comparison is determined in kWh/m<sup>2</sup>-years and is based on the life cycle of building previously established for 70 years.

Finally, OE and EE comparison has taken into account the values refer only to non-renewable sources of the surfaces bounding the only heated room (as provided by law for the energy rating of the Piedmont Region).

Is demonstrated that the proportion of OE is greater EE remaining the most important in the energy balance of a building. The EE in the overall energy balance, however, it can't be ignored and should be taken into account in the assessment.

The analysis of EE and the life cycle in general, therefore should be included in energy certifications and in the diagrams of calculation, in order to effectively bring the building sector towards sustainability.

For further information, e-mail:

Veronica Valentini: [veronica-valentini@libero.it](mailto:veronica-valentini@libero.it)

---

Maintained by:

CISDA - HypArc, e-mail: [hyparc@polito.it](mailto:hyparc@polito.it)