

ABSTRACT

Using a simplified Life Cycle Assessment, cumulative energy demand and carbon footprint was evaluated of four new houses located in Temuco - Chile, structured with SIP (Structural insulated panel), in order to quantify the energy at each stage of this construction system.

To obtain embodied energy were used two databases, the energy contained in the panel assembly process, transport and construction of the houses was determined by a data at the factory of panels and operational energy, was estimated through computational models

The analysis show that the energy contained by construction processes represents about 1.5% of embodied energy, while the total energy embodied represents 10% of the total life cycle energy of houses, the remaining 90% represents the energy of occupation. SIP houses generate figures close to 60% savings in energy demand, compared to a common masonry houses with no method of thermal insulation. On the other hand, the carbon footprint was estimated in 9.239 kg CO₂ eq of materials production; 286 kg CO₂ eq of construction processes; and 371.470 kg CO₂ eq of operational energy (50 years lifespan) in average.

METHODOLOGY

Goal and scope

The aim of this study was to compare different dwellings available on the building market today in the city of Temuco, Chile, according to their embodied and operational energy.

Inventory

The inventory analysis was performed through databases, literature, equipment manuals, information providers and on-site survey data at the factory of panels.

Methodology

To obtain embodied energy were used two databases in order to quantify the energy of each material, Inventory of Carbon & Energy (ICE), 2008, University of Bath, Inglaterra and New Zealand Building materials embodied energy coefficients database. Volume II – Coefficients, 1998, Victoria University of Wellington, and the energy contained in the panel assembly process, transport and construction of the houses was determined by a data collection company specializing in the construction of houses built in SIP.

Operational energy, was estimated through computational models, they were carried out with Design Builder software, with information of the house from thermography and infiltration essays, and this energy was projected at 50 years lifespan.

The emission of CO₂ was determined separately in the two life cycle stages. For the first stage the equivalent CO₂ associated with the energy content was determined and for the second stage, the emission of CO₂ from the stage of occupation associated with the fuel employed.

RESULTS AND DISCUSSION

Table 1 shows the results and analysis of four homes built with SIP, the first two houses are a typology common in southern Chile, while houses 2 and 3 are modular

CONCLUSIONS

The amount of energy in homes and modules represents an average of 5.4 years energy demand in respect of all occupational energy calculated over 50 years. The embodied energy is on average only 10% of the all the energy in the life cycle of housing, remaining 90% goes to the energy of occupation. Occupation is the most important stage in terms of cumulative energy demand in homes studied. CO₂ eq emissions are directly dependent on energy and to be estimated with emission factors. The stage of operation is the largest contributor to the carbon footprint of the house.

Table 1: Energy and CO₂ emissions at each stage by house

	Area [m ²]	Energy					CO ₂ eq Emissions		
		Embodied Materials [kWh]	Construction Electric [kWh]	Process Gas [kWh]	Operation Diesel [kWh]	Heating [kWh/yr]	Embodied Materials [kg CO ₂ eq]	Construction Process [kg CO ₂ eq]	Operation Heating [kg CO ₂ eq/yr]
House 1	75.0	46914.7	625.0	84.8	22.9	8769.0	12748.4	364.2	10469.8
House 2	60.0	39421.6	500.4	67.8	8.1	7365.3	12079.2	269.3	9141.7
House 3	35.0	17221.0	291.3	39.6	11.5	3106.8	5372.6	174.6	4459.9
House 4	50.0	23066.9	417.0	56.5	11.5	4674.8	6462.0	237.5	5654.0

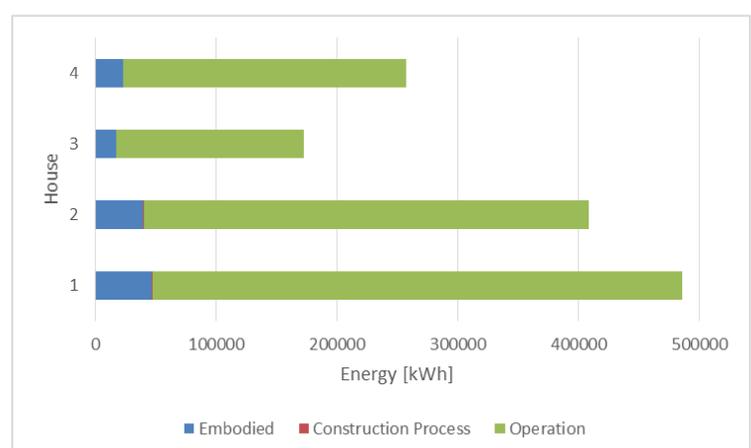
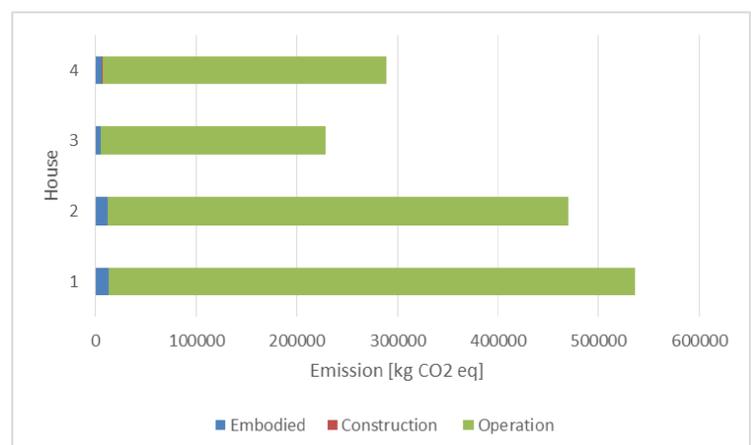


Figure 1: (a) Energy at each stage by house projected at 50 years of service life (b) CO₂ eq emissions at each stage by house projected at 50 years of service life