Environmental implications in the substitution of non-renewable materials by renewable materials

A case study of cork as thermal insulation in buildings

Jorge Sierra-Pérez[1,2], Jesús Boschmonart-Rives[1,3] and Xavier Gabarrell [1,4]

1 Sostenipra (ICTA – IRTA - Inèdit Innovació SL) 2014 SGR 1412. Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB), 08193 – Cerdanyola del Vallès (Bellaterra), Barcelona, Spain.
2 Centro Universitario de la Defensa. Ctra. de Huesca s/n, 50.090, Zaragoza, Spain
3 Inèdit Innovació, S.L. Parc de Recerca de la Universitat Autònoma de Barcelona (UAB), 08193 – Cerdanyola del Vallès (Bellaterra), Barcelona, Spain
4 Department of Chemical Engineering (XBR), Universitat Autònoma de Barcelona (UAB), 08193 – Cerdanyola del Vallès (Bellaterra), Barcelona, Spain

Corresponding author: jsierra@unizar.es; Tel: +34 976 739 836

III PREMI TORRES&EARTH
A LA INNOVACIÓ MEDIAMBIENTAL

1. Introduction

Widespread environmental strategy of reducing the environmental impact is to minimize the use of non-renewable materials which involve important impacts to the environment at different stages of the life cycle. The replacement of non-renewable materials by renewable materials implies a very important decreasing in the most life cycle phases. Nevertheless many natural materials, widely used, also have a high geographic concentration and the environmental implications of their distribution are highlighted. This is the case of cork, that 80% of its production is concentrated in the coastal regions of the western Mediterranean basin, mainly in the Iberian Peninsula, where a powerful industry related to cork exists. The Iberian Peninsula cork industry and its products has been analysed by Sostenipra research group from an economic and environmental view [1, 2].

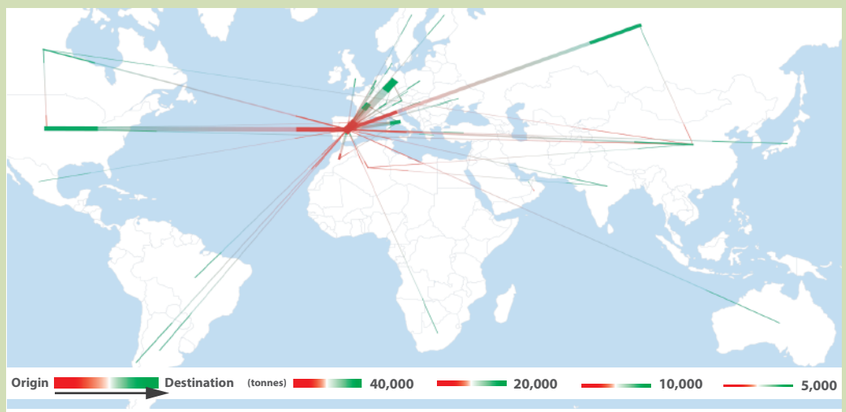


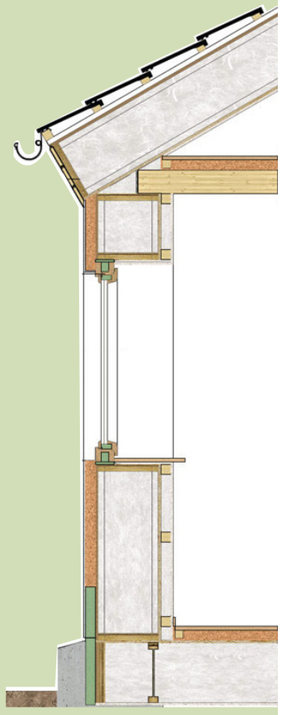
Figure 1. The global trade distribution of Iberian cork products (UN Comtrade 2013, Boyandin et al. 2010)

Cork has an outstanding properties as thermal and acoustic insulation and good resistance to degradation by moisture. Currently, due to their intrinsic properties, Insulation Cork Board (ICB) is used in the construction industry as insulation, though in a limited way.

The European market of insulation materials is still dominated by two groups of products, which are classified according to their chemical or physical structure:

- mineral or inorganic fibrous materials, namely glass wool (GW) and stone wool (SW), which account for 60% of the market.

- organic foamy materials, like expanded polystyrene (EPS), extruded polystyrene (XPS) and the polyurethane (PUR), which account for about 30% of the market [3][4].



2. Materials and methods

Objectives

This study determines the environmental implications in the substitution by ICB instead of the most used materials in the building insulation: GW, SW, EPS, XPS and PUR. Assessing the environmental impact of different insulation materials following the LCA methodology from cradle to site.

Methodology

The LCA methodology was applied to determine the environmental impacts., including global warming potential (GWP) and the Embodied Energy (EE) in building materials from all processes of production and transport to site [5,6].

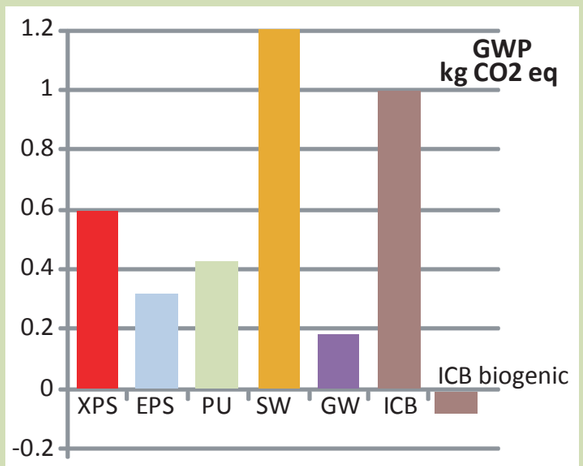
The functional unit considered is defined as the mass (kg) of insulation board that provides a thermal resistance R-value of 1(m2 K/W) and area A of 1m2.

	XPS	EPS	PU	SW	GW	ICB
Transmitance (U) (W/m2 K)	1	1	1	1	1	1
Thermal conductivity (λ) (W/m K)	0.032	0.035	0.023	0.039	0.036	0.004
Density (kg/m3)	20	35	31	130	21.8	110
Weight (kg)	0.64	1.23	0.71	5.07	0.78	4.4

3. Results and discussion

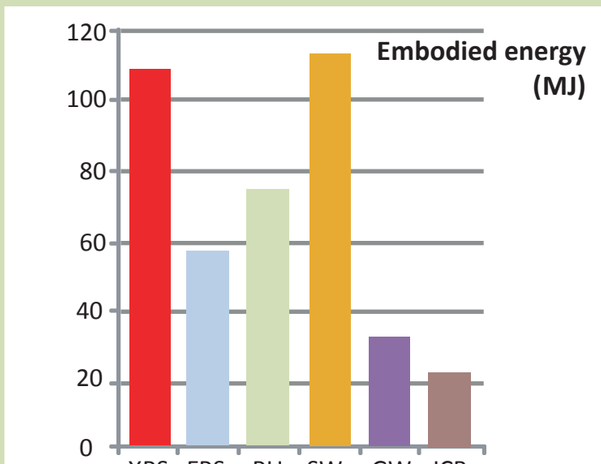
In the global results, there are significant differences between the environmental impacts of different materials. If the biogenic carbon contained in cork is not taken into account, cork has one the worst results in kg of CO2 eq. The best environmental performance is for Glass Wool and the worst for Stone Wool.

When the carbon fixed by tree is considered, the final impact of the cork board is negativ, that is, it can help to mitigate the climate change of the entire building.



Regarding the Embodied Energy in the materials, for the one hand, ICB has the lowest value. The highest value of embodied energy is XPS and SW.

Insulations materials have a key role in the efficient of buildings, due to help to decrease the energy consumption during their use. For that, it is important using a low energy material as cork, to obtain a global decrease in the total life cycle energy of building.



4. Conclusions

· The study shows that, under similar working conditions, the substitution of non-renewable materials by renewable and natural materials, such as cork, could favor widely the reduction of environmental impacts in the entire life cycle of a building. ICB has less environmental impact in GWP and EE terms than the others insulation materials.

·Insulations materials have a key role in the efficient of buildings, due to help to decrease the energy consumption during their use.

· It is important taken into account the total life cycle energy of building, and select an insulation material that help to reduce the energy consumption during the use of building but algo during its manufacturing

References

[1] Sierra-Pérez, J., Boschmonart-Rives, J., & Gabarrell, X. (2015). Production and trade analysis in the Iberian cork sector: Economic characterization of a forest industry. Resources, Conservation and Recycling, 98, 55-66.

[2] Rives, J., Fernandez-Rodriguez, I., Rieradevall, J., & Gabarrell, X. (2011). Environmental analysis of the production of natural cork stoppers in southern Europe (Catalonia–Spain). Journal of Cleaner Production, 19(2), 259-271.

[3] a. M. Papadopoulos, “State of the art in thermal insulation materials and aims for future developments,” Energy Build., vol. 37, no. 1, pp. 77–86, Jan. 2005.

[4] F. Pacheco-Torgal, “Eco-efficient construction and building materials research under the EU Framework Programme Horizon 2020,” Constr. Build. Mater., vol. 51, pp. 151–162, Jan. 2014.

[5] European Committee for Standardization, “EN 15804:2012+A1, 2013. Sustainability of construction works - Environmental product declarations – Core rules for the product category of construction products.” 2014.

[6] B. P. Guinée, J. B., Gorrée, M., Heijungs, R., Huppes, G., Kleijn, R., De Koning, A & Weidema, Life cycle assessment; An operational guide to the ISO standards; Parts 1 and 2. Den Haag and Leiden, The Netherlands: Ministry of Housing, Spatial Planning and Environment (VROM) and Centre of Environmental Science (CML),, 2001.