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# Sheep wool for sustainable architecture

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**Abstract**

Sheep wool is a natural material, already used for thermal insulation of pitched roofs, in the form of soft mats. The paper presents a research project called Cartonlana, concerning a new sheep wool-based product with two main innovative features: it is a stiff panel, unlike the existing soft wool mats; it has a low environmental impact, using local recycled sheep wool, otherwise disposed as special waste. Physical and chemical properties of Cartonlana panel were determined by measurements, in order to demonstrate its effectiveness as insulation for buildings: thermal conductivity, acoustic absorption coefficient, absorption of formaldehyde, thermal transmittance of a wall.



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*Keywords:* sheep wool; thermal conductivity; acoustic absorption coefficient; sustainable architecture.

## 1. Introduction

Sustainable architecture needs natural materials with low environmental impact and physical performances which meet the requirements imposed by regulations concerning energy consumptions of buildings [1]. Sheep wool is a natural material suitable for thermal and acoustic building insulation. Taking into account the national context (Italy), the sheep wool insulation products already available in the building market can be divided into two categories:

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- soft mats made of 100% sheep wool, with thicknesses between 4 and 6 cm, mainly used for the insulation of pitched roofs;
- semi-rigid panels made of sheep wool (70-80%) and polyester fibers (20-30%), with thicknesses between 5 and 12 cm. The stiffness, obtained through the partial fusion of the polyester fibers, also allows for application in walls.

A research conducted by the Politecnico di Torino, Department of Architecture and Design (DAD), [2, 3] has evidenced some critical points concerning the economic and social aspects of the wool production-chain in the Piedmont Region, in Italy, such as:

- sheep farming is mainly geared for the production of milk and meat;
- sheep are not selected for the quality of their wool, which cannot be used by textile industry;
- wool, in most cases, is improperly disposed. It is buried or burned, with a strong impact on soil and air pollution;
- sheep wool building products are in most cases made of wool imported from foreign countries.

## 2. Cartonlana, an innovative building product

Starting from the critical issues analysed above, DAD, Davifil s.r.l. and ISMAC CNR carried out a research project concerning Cartonlana, a semi-rigid thermo-acoustic insulation panel obtained from Piedmont recycled wool [2, 3]. The study investigates an innovative way to produce an insulation panel with low environmental impact and high stiffness, using the low quality sheep wool collected in the Piedmont Region.

### *2.1. Low environmental impact*

The low environmental impact of sheep wool-based building products is demonstrated in literature [2, 3, 4]. In particularly, the following wool life cycle stages must be considered: raw material supply, transport, end of life. In Cartonlana the raw material is represented by low quality wool, not suitable for the textile industry, and considered as special waste according to national regulations. Therefore, the impact of raw material supply is minimized, considering the avoided impacts of wool disposal. Concerning transport, the lack of wool collection facilities represents a huge limit to its utilisation, and pushes wool insulation producers to buy raw material from foreign countries, increasing the impact of transport on the environment. For instance, the primary energy content of transports of wool from New Zealand averages 10% per kilogram of the final product [3]. Considering the end of life stage, the compositions of the panel is important: panels with polyester fibres cannot be recycled as the 100% wool soft mat or stiff panel, which can be re-used in various innovative ways, like, for example, as a high value agricultural fertilizer [5].

Hence, Cartonlana stiff panel (Fig.1 - product C2) has been compared with other insulating wool products available on the Italian construction market: the 100% wool soft mat (Fig. 1 - product A) and the semi-rigid wool and polyester panel (Fig. 1 – product B). An environmental evaluation based on the Life Cycle Assessment methodology defined by the UNI EN ISO 14040/44 [6] has been made in order to analyse the potential environmental impact of each product. Life cycle inventory data are collected directly from the industrial partners of the research project. It has been assumed that all the three products are made of recycled sheep wool from Piedmont. Figure 1 shows a comparison between the three products in term of mega joule of non-renewable resources per kilogram. The washing process requires a large amount of energy for all the three products. Product B requires more energy than A and C2 for the raw material supply. Considering the total use of not renewables resources, C2 is similar to A, but has a higher manufactory process impact.

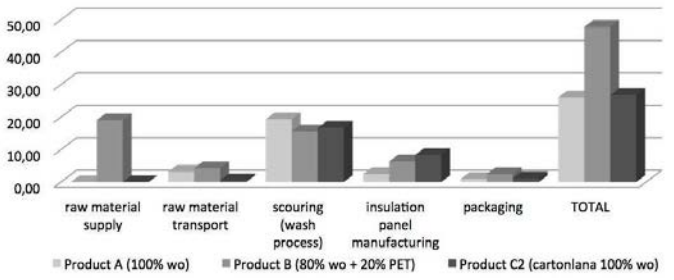


Fig. 1. Use of resources in the processing steps for manufacturing different wool insulation products (A, B, C2)