

Hemp-Based Insulation: Measuring the Environmental Benefit from Field to Factory

Hemp has earned considerable attention as a renewable raw material, particularly in construction. One of the most interesting applications is thermal insulation made from hemp fibre. Because hemp absorbs carbon dioxide while growing, these materials are sometimes described simply as “carbon negative.”

The reality is more nuanced—but also more interesting. Rather than weakening the environmental case for hemp, a closer examination shows where its advantages come from and how they could become even stronger.

A 2025 study published in the Journal of Cleaner Production provides an excellent example. Researchers Farnaz Nazari and L. Damon Woods conducted a detailed life-cycle assessment (LCA) of hemp-based thermal insulation produced in the United States. They followed the material from cultivation through processing, transportation and manufacturing into finished insulation.

Looking beyond the field

A major strength of life-cycle assessment is that it considers more than the raw material itself. The study used a “cradle-to-gate” approach, covering the journey from growing the hemp until the finished insulation leaves the factory.

This is important because every material has an environmental footprint.

Hemp must be planted and harvested. The stalks are processed to separate useful fibres, those fibres are transported, and manufacturing them into insulation requires electricity and additional materials. Together, these activities contribute to the product's embodied carbon—the greenhouse gas emissions associated with producing it.

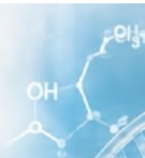
Looking at these stages makes the environmental case for hemp more credible. Its performance does not have to depend on the assumption that a natural material must automatically be sustainable. It can be measured.

Hemp brings something extra to the equation

Where hemp becomes particularly interesting is what happens before manufacturing even begins.

Like other plants, hemp removes CO₂ from the atmosphere through photosynthesis and incorporates carbon into its biomass. When hemp fibre becomes a durable building material, some of this biogenic carbon remains stored within that product.

The 2025 study illustrates how significant this can be.



Using the EN 15804 methodology, which accounts for biogenic carbon, the researchers calculated a climate-change impact of -0.198 kg CO₂-equivalent per functional unit for U.S.-produced hemp insulation. When they used the TRACI 2.1 methodology, which excludes biogenic carbon, the result was $+1.099$ kg CO₂-equivalent.

This difference deserves attention. It also explains why claims that hemp is simply “carbon negative” should be treated carefully. The result depends partly on how carbon uptake and storage are accounted for.

But that qualification should not distract from the underlying advantage: hemp begins its life as a material by actively removing carbon dioxide from the atmosphere. That gives hemp-based products an opportunity that many conventional materials simply do not have.

A strong result—with room to improve

The comparison with conventional insulation is equally revealing.

When biogenic carbon was included, hemp insulation showed particularly low climate impacts. When it was excluded, hemp ranked behind fiberglass and rockwool in the study, but still performed better than expanded polystyrene (EPS) and extruded polystyrene (XPS).

Rather than being a weakness, this points toward an opportunity.

The environmental performance of hemp insulation is influenced by agricultural practices, crop yields, processing technologies, transportation distances and the energy used in manufacturing. Improvements anywhere along that chain could strengthen the overall result.

A hemp insulation factory powered by lower-carbon electricity, for example, may have a different footprint from one relying on a more carbon-intensive energy mix. Shorter transportation routes, efficient fibre processing and improvements in cultivation can also matter.

In other words, hemp's environmental potential is not fixed. It can be improved.



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From a sustainable crop to a sustainable system

Perhaps that is the most encouraging conclusion.

Hemp does not need exaggerated environmental claims to be an exciting material. It is renewable, captures atmospheric carbon while growing and can store part of that carbon when incorporated into long-lasting products. At the same time, life-cycle assessment helps identify exactly where the industry can improve cultivation, processing, transportation and manufacturing.

So instead of asking only, “Is hemp carbon negative?”, there is a more useful question:

How can we design hemp supply chains that make the greatest possible use of the plant's natural environmental advantages?

That shift matters. It moves the conversation from marketing claims toward measurable progress—and gives consumers, builders and manufacturers good reason to feel positive about choosing hemp.

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