Carbon in wood products – translated to plain English.

By Lloyd Irland

You probably have been reading a lot about the value of wood structural materials as ways to store carbon, thus slowing the accumulation of carbon dioxide (CO_2) in the atmosphere. This would be one benefit of building larger structures with advanced wood composites instead of steel and concrete. So, it is often asked, how much carbon does get stored in a new house? How much CO_2 emissions can be saved by using wood to replace other building materials? This can get confusing very fast.

So, I offer this somewhat simplified primer to prepare you for a series that will walk you step by step through some of the practical issues we encounter when trying to think about carbon emissions and the role of forestry and wood products in the global carbon cycle. If we cannot think clearly about these matters, then our individual consumption choices or our state and national policies may be misguided.

First, metric units:
A metric tonne (note spelling) is equal to 1,000 kilograms, or 2,200 pounds, or 1.1 english tons. The rest of the world measures CO_2 in metric tonnes, and scales wood in cubic meters. We're the outliers who use "English" units (even the English use metric). International treaties on CO_2 emissions, emissions trading systems, and scientific work measuring carbon stocks and flows, all use metric units. So, we need to translate a lot of information into familiar English units.

This cubic meter of wood is roughly equivalent to a tonne of carbon dioxide. This stands in the ground floor lobby of the Forestry program at the Technical University of Munich's campus in Freising.

Here's what a tonne of CO_2 looks like:

This infographic stood outside the large conference hall where the Copenhagen Climate Conference was held in 2009.

Confusing Carbon with CO_2:
You often read of "carbon storage", or "carbon sequestration," followed by numbers of tons. It can be hard to keep track of whether the writer is talking about carbon or CO_2. Obviously carbon does not hang around in the atmosphere by itself – it only gets there because organic material (or something) gets burned or oxidized to CO_2. Ecologists have spoken for decades about the "carbon cycle", and have measured ecosystem productivity in terms of carbon fixed per unit of area. This was an extremely important breakthrough in how ecosystems were perceived and understood. But gases forcing climate change are always discussed in terms of CO_2, or the equivalent.

The number to remember here is 3.67. High school chemistry told us that every carbon dioxide molecule consists of two oxygen atoms (atomic weight 16), attached to one carbon atom (atomic weight 12). So, two times sixteen plus one times 12 equals 44. For every ton of carbon atoms in wood cellulose, you'll have 44/12 (or 3.67) tons of CO_2. This factor is dimensionless so you can use it with metric or English tons.

Measuring Weight versus Volume:
At one time, we thought of forest products in volume terms – we stick-scaled board feet of sawlogs or veneer, as well as, cords of pulpwood, firewood, or pallet wood. Since we scale standing trees in volume terms, this made good sense. In the 1970's, however, many paper mills converted to what was then termed

"weight-scaling," followed years later by spruce sawmills. The state price reports show prices per ton for many products now, so if you want log volume you need to convert back. Today, the USFS timber resource reports do us a favor, by reporting wood volumes in the forest as tons in addition to traditional volumes.

Now we can walk through an illustration on how this all works. Table 1 deals with one cubic meter (m3) of wood raw material, as in the photo, and takes it to US tons per m3 of solid wood raw material. Numbers used below are illustrative, but reasonable; you'll find different ones here and there if you look long enough. You'd be amazed at how the weight of a cord of spruce fir can vary by soil type, age, and season.

Table 1: Tons of CO_2 per cubic meter of wood

				Canadian Spruce	Oaks*	Douglas fir
1	Dry weight per m3	Given	kg	450	750	530
2	Carbon weight	Row 1 x 0.5	0.5	225	375	265
3	Kg CO_2 per kg Carbon	Row 2 x 3.67	3.67	826	1376	973
4	Tonnes CO_2 per m3	Row 3/1000		.83	1.38	.97
5	US (english) tons per m3	Row 4 x .907	.907	**.75**	**1.25**	**.88**

** Midpoint of range*

In the US we typically measure lumber in nominal volume units, not actual volumes; also we traditionally measure pulpwood by the stacked cord, which is not the actual volume of wood in the pile. So it can be some work to bring all measures to a common unit. The next table shows the tons of CO_2 in familiar volume units use in the US:

Table 2: Tons of CO^2 per American Unit of Wood

	Spruce lumber	White pine lumber	Douglas fir plywood	Aspen lumber	Oak lumber	Spruce/fir pulpwood	Mixed hardwood pulpwood
Per Mbf Zero MC	4.0	3.5	4.9	3.8	6.2	n/a	n/a
Per green cord	n/a	n/a	n/a	n/a	n/a	1.9	2.3

Standing timber to end products

A ton of standing timber does not all end up in a finished product. Depending on species and tree size, anywhere from 4 to 12% of this weight might be bark. There is inevitable shrinkage in processing. For lumber, for example, as much 50% of the wood in a small log goes into slabs, shavings, sawdust and fines, not into the lumber pile. When a ton of wood goes in one end of a sulfate pulp mill, only half a ton of pulp emerges from the other end. A ton of finished glossy paper can be 30% nonwood fillers and coatings.

Carbon in a Board? Cradle to Grave emissions?

Many times you'll read that a ton of wood "contains" so and so much carbon or CO_2. This may mean the carbon in the board itself (as I show in Table 2). In some analyses it also includes the board plus "cradle to the grave" emissions – counting all fuel and power usage during harvesting, processing, kiln drying, and shipping. Does it include allowance for onsite construction waste or other falldowns along the way? Even more complicated, many mills produce all or most of their onsite energy from bark, offcuts, or other residuals. Trouble is, a writer may have found this number someplace and have no idea exactly what it actually means. We often read of the carbon "stored" in a house. This seems to refer only to the C content of the products themselves.

Confused yet?

You're not alone. Every time I return to this topic I find myself confused until I get back into the groove again.

Final thought

Please let us know if you know of a wood shop who will make a cubic meter of wood for a display illustrating tons of CO^2 per cubic meter of wood and prepare plans that others might use. Email Jenn Hicks: jenn@mainewoodlandowners.org

Editor's note: This is the first in a series of articles on carbon.

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