Caveat Emptor:
Sustainability, Wood and the Environment

Environmental claims being made by the wood industry must be carefully evaluated.

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A simple Google search of environmental impacts related to wood yields 5.67 million suggested links. The sheer volume of the often contradictory claims regarding the sustainability of wood products is overwhelming and confusing. Clearly there is more information than the most diligent researcher could possibly pursue. And even if it were possible to read each document, it would become quickly evident that each report or study carries with it a distinct set of biases. Some are written from the perspective of those who wish to protect our forests, many are written by the wood industry and the U.S. Department of Agriculture promoting the increased use of wood. Others are written by competing industries attempting to protect their slice of the market and others still are written by academics seeking accurate measures of environmental impacts.

The majority of these contradictory reports are "scientifically" defensible. How can defensible reports be in contradiction with each other? The answer is simple—each report is based on a different set of assumptions regarding the type of wood being considered, the forest management and harvesting practices being employed, the treatment of by-products and waste, the boundaries applied to the study, the type of life cycle assessment being performed, the methodology of the life cycle assessment being utilized and the basis of comparisons being made to other materials.

Clearly the buyer must beware. Making beneficial assumptions, selecting the "right" methodology and limiting the scope of the study can always result in a positive message. However the closer those *a priories* are examined simple statements such as "wood is a green material that sequesters carbon and has the least environmental impacts of any material" do not stand the test of rigorous analysis.

To objectively consider the environmental impacts of wood (or any material) several key questions must be asked:

- What assumptions are being made?
- What product boundaries are being imposed?
- What impacts are being considered?
- What methodology is being used?
- What comparisons are being made?

What assumptions are being made?

The environmental impacts of tree species vary based on several factors. The USDA states that over 400 tree species exist in the U.S.[1] A study performed in 2003 evaluated 87 of these species and categoeized their differences. For instance the biomass density of these species ranged from a specific gravity of .29 to .81 while carbon sequestration rates for 20 year old trees of different species varied by as much as 400%[2]. Not all tree species are the same and any claims related to the environmental impacts of *wood must be identified as to the species of wood being evaluated*.

Likewise it is important that the results being published regarding wood products not be extrapolated to engineered wood products such as cross laminated timber (CLT). CLT is not a pure wood product but contains a significant quantity of adhesives to bind the wood material together into CLT. *Environmental impacts associated with engineered wood products must include additional chemicals added to the product as well the production impacts*.

Most, if not all environmental impact studies published by the wood industry assume that the wood is sourced from forests that are sustainably managed and that the wood is harvested in a sustainable manner. This assumption is critical to the wood industry argument that an increase in wood consumption would not reduce forest

acreage in that new trees will be planted to replace those trees which have been harvested. Yet a recent white paper from the American Forest and Paper Association (AF&PA) indicates that only 7% of forests in the U.S. are certified as being managed sustainably (FSC) and only 12% of the harvesting practices are certified as being sustainably performed (SFI)[3]. *Any environmental claims based on an assumption of sustainable management and harvesting only apply to wood products from those forests.* The majority of U.S. forests do not meet this requirement.

Closely related to the assumption that all forests are being harvested and managed sustainably is a second assumption that the carbon uptake in an acre of new seedlings is the same as the carbon uptake in an acre of mature forest land. Comprehensive data comparing carbon uptake by species by life stage is difficult to quantify, but the fact is that trees consume CO_2 at different rates throughout their lifetime both as a function of the longevity and density of foliage and planting density[4]. Any study of wood's environmental impacts, even in sustainably managed forests, cannot be a point in time study but must *take into account the impact of timing on the net impacts*.

It is also necessary to define the assumptions being made regarding the amount of waste generated by the harvesting and milling process. Some wood studies have claimed 99% consumption of the biomass material of the trees being harvested. Yet other studies indicate that only 36% of a harvested tree ends up as a wood product when typical harvesting and milling practices are evaluated and the total mass of the tree including the root system is included[5].

Why is this value so low? 40% of the original tree is left behind in the forest (small branches, leaves, bark, roots). Of the 60% that makes it to a sawmill another 40% of the wood is lost between the log and the production of the lumber. "About 40 percent of milled logs end up as either sawdust, trimmings and other odds and ends", says Steve Kelley, PhD, head of the department of forest biomaterials at North Carolina State University. "When you cut a cylinder into rectangles, you lose a lot of good wood in that process," he says[6].

What happens to the 64% of the tree that is waste? The portions of the tree which are left in the forest are either burned or left to decay over time. Both of these processes release CO_2 into the atmosphere. The natural decomposition of this waste releases NO_2 and methane, which are even more damaging to the environment than CO_2. On average typical lumber operations result in six tons of debris per acre harvested. In many cases the area harvested is treated with a harmful herbicide containing the same basic compound 2,4-D as the infamous Agent Orange used as a defoliant during the Vietnam War[7]. The wood waste from the milling process is collected as chips and sawdust and either land filled, burned, pelletized or bound with adhesives to form engineered wood products.

The wood industry often claims a reduction in environmental impacts based on the "use" of pre-consumer wood waste material for energy production including home heating. Yet the CO_2 production of burning wood waste is actually higher per BTU than burning coal with wood smoke identified as having a negative health impact effectively negating its positive environmental impacts[8]. In San Francisco the Bay Area Air Quality Management District stated that "burned wood releases more particulate pollution than the entire region's vehicles and business…"[9] Wood burning is the second largest source of dioxins in the Bay Area. These dioxins end up in the bay, ocean, creeks, and soil, where they accumulate in fish and livestock, poisoning our food supply. *Wood environmental impacts must account for emissions related to incineration as they are not reducing net environmental impacts*.

The values for wood waste cited above do not include the post-consumer waste generated by wood products including construction, demolition (C&D) and municipal solid waste (MSW) collection. According to the U.S. Forest Service 52.2 million tons of post-consumer wood waste was generated in 2010 (15.8 million tons of MSW, 36.4 million tons of C&D) of which 28.1 million tons (54%) ended up in landfills[10]. The anaerobic decomposition process of organics such as wood which takes place in landfills is the single largest source of methane, CH_4, released into the atmosphere. CH_4 is 23 times more potent as a greenhouse gas than CO_2[11]. *Any evaluation of the environmental impacts of wood products must take into account the actual levels of waste being generated on both a pre-consumer and post-consumer basis and the impacts related to the disposal of that material.*

It should be noted that the discussion does not distinguish between wood species but addresses the topics in general in terms of the assumptions that must be fully defined for an analysis to take place. However, a study by CIRAG has recently shown that the method of end-of-life disposal of wood products can result in huge swings in impacts of as much as 2,700 kg of CO_2-eq per cubic meter of North American lumber.[11]

What product boundaries are being imposed?

Closely related to the issue of the environmental impacts of wood waste is the definition of the boundaries of the life cycle assessment (LCA) being performed to calculate those impacts. An LCA which ignores the use, maintenance, operation, deconstruction, and waste collection/ decomposition/incineration phases of a product does not provide an accurate analysis of the full environmental impact of wood. Accounting for land-clearing, habitat disruption and planting operations are also critical to a full LCA for a wood product. Understanding the boundaries which define an LCA is critical to assessing the environmental impact of wood. An LCA which only accounts for the harvesting and milling of lumber is an accurate picture of only those two stages, not the front and back end of the life of the product. *A full view of any product should take into account the full life cycle of the product.*

Unlike other materials, wood is not a cradle-to-cradle material where the majority of products at the end of life are reused or recycled back into new products. It is a cradle-to-grave product that that has a distinct end to its life at which time any carbon sequestered in the product makes its way back into the atmosphere. Granted this release of sequestered carbon may take place over an extended period of time, but ultimately it will return to the atmosphere.

The wood industry often claims that using a wood will result in the sequestration of CO_2. That may be a true statement. However, what is ignored is that while the wood used in construction today is sequestering carbon, the wood used previously in construction is being demolished, landfilled or burned and releasing its carbon back into the atmosphere. For that reason *any claim of carbon sequestration must be made on a net rather than absolute basis.*

While wood is a plant material that grows from a seed released by the original tree it is inaccurate to refer to wood as a regenerative material. It is a bio-based material that does not regenerate itself but rather provides the basis for a new life cycle requiring new resources and generating new impacts.

What impacts are being considered?

In reporting environmental impacts global warming potential measured in CO_2 equivalents is only one of large number of environmental impacts that can be reported. LCA professionals often argue that it is inappropriate to even rank the variety of impacts in terms of importance. *To truly assess the environmental impacts of any material requires a look at all impacts.*

The wood industry has consistently published impacts listing only global warming potential, ozone depletion, eutrophication, acidification, depleting of stratospheric ozone, formation of tropospheric ozone. They have strongly resisted the quantification of impacts related to land use, resource consumption, human health impacts, toxicity, habitat alteration and biodiversity. This has led the Sierra Club to comment on wood industry environmental product declarations (EPDs) stating "the primary purpose of current EPDs for wood appears to be to divert attention away from destructive forest management practices which cause disturbances to forests, streams, wetlands, and eliminates habitat for wildlife, all to sell more wood."[12]

In effect the wood industry has failed to transition from the promotion of wood as a bio-based single attribute material publishing only those impacts directly related to the biomass characteristics of wood to a *multi-attribute assessment of a wide range of critical impacts.*

What methodology is being used?

Every LCA is not the same. Independent of the product being analyzed each LCA process includes certain assumptions related to the performance of the LCA. Two of the major assumptions involve the credit or burden being assessed to the product based product substitution and end-of-life reuse or recycling. The wood industry typically takes a credit in their LCAs based on waste-to-energy incineration of wood. The credit taken is the equivalent of the environmental impacts related to the production of energy using other fuels such as coal or oil. However, if the principles of product substitution were to be properly applied, then *wood should be assessed a burden as the emissions associated with wood combustion, even in modern incineration plants, is greater than that of alternative fuel sources.*

Even more important is whether the LCA is being developed using an attributional or a consequential methodology. An attributional LCA looks at the micro-level, steady state environmental impacts in current terms based on the known impacts for a given quantity of the material. A consequential LCA seeks to quantify the system level impacts that would occur if the use of a product were to increase.

The wood industry is promoting increasing the use of wood in construction. What would this mean relative to resource utilization, sawmill construction and operation, land use, habitat disruption, ozone depletion and the entire list of environmental impacts? And what would it mean relative to the impacts of the materials that are the target of displacement? The results of a consequential LCA are often significantly different than those of an attributional LCA. *If the wood industry is promoting an increase in the use of wood the LCAs that are being prepared should be consequential rather than attributional LCAs.*

What comparisons are being made?

LCAs were originally intended to provide a tool for monitoring the improvement in the production of a product. In that case the methodology being used to assess the original product and the subsequent "identical" product would be consistent.

LCAs have since been seen as a means of comparing two dissimilar products. This is not a proper function of an LCA. When dissimilar products are being compared the LCA methodology will almost certainly be different. The declared unit will probably be different. And the quantity of material required to fulfill the project requirements will always be different, e.g. structurally a ton of steel provides greater structural capacity than a ton of concrete or a ton of wood.

The bottom line is that there cannot be a direct comparison between the environmental impacts associated with various dissimilar products. It is impossible to say that wood is "greener" than, for example, concrete.

What can be said though is that in a given building application when two buildings with similar requirements and configurations are designed to a level of detail necessary for an accurate estimation of structural quantities (not based on parametric estimates from a simplified LCA tool) a comparison can be performed on a whole building LCA level. The legitimate conclusions that can be drawn at that level would be that "for this structure in this location with these requirements a structural framing system using material A contributes to a lower level of environmental impacts than a structural framing system using material B."

Unless a project based, whole building life cycle assessment is performed claims of environmental superiority of one material compared to another are worthless, marketing hype.

The reality is that it is often a combination of materials each contributing to the project in the most environmentally efficient manner that will often demonstrate the lowest environmental impacts.

Caveat Emptor

So as the Romans said "let the buyer beware." Probe the assumptions. Examine sources for potential biases. Evaluate the methodologies. And don't short circuit a rigorous methodology for accurately comparing the environmental impacts of alternative construction materials on a whole building life cycle assessment basis.

Sources

[1] USDA website, 2016.

[2] Jennifer Jenkins, David Chojnacky, Linda Heath and Richard Birdsey, "National Scale Biomass Estimators for United States Tree Species" Forest Service 49(1), 2003.

[3] U.S. Department of Energy, "Method for Calculating Carbon Sequestration by Trees in Urban and Suburban Settings", April, 1998.

[4] American Forestry and Paper Products, "AF&PA White Paper—Sustainable Forestry and Certification Programs in the United States", March 10, 2016. Even ASTM D-7612 which references all levels of forest certification programs in the United States indicates that only 25% of the forest lands are certified, let alone sustainably certified.

[5] Ann Ingerson, "2009 Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis?", The Wilderness Society, April, 2009

[6] Steve Kelley, quoted on www.bioenergyconnection.org website

[7] Solomon, *The Atlantic*, "Agent Orange in Your Backyard", February 24, 2012.

[8] Booth, "Trees, Trash, and Toxics: How Biomass Energy Has Become the New Coal", PFPI, 02Apr2014— It should be noted that based on permit submission, the "cleanest" of the biomass plants emit >150% nitrogen oxides, >600% VOCs, >90% particulate matter and >125% carbon monoxide. Compared to natural gas, wood exceeds natural gas emissions in every category by >800%.

[9] Mark Lundberg, MD quoted on Families for Clean Air website

[10] Steve Bratkovich, Jeff Howe, Jim Boyer, Ed Pepke, Matt Frank and Kathryn Fernholz, "Municipal Solid Waste (MSW) and Construction and Demolition (C&D) Wood Waste Generation and Recovery in the United States", Dovetail Partners, September 22, 2014.

[11] USEPA, 2007, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, USEPA #430-R-07-002, U.S. Environmental Protection Agency, Washington, DC quoted in U.S. Composting Council Position Paper, "Keeping Organics out of Landfills"

[12] CIRAG Study for the American Iron and Steel Institute, not published

[13] Sierra Club statement, September 24, 2013

There's always a solution in steel.

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