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Dec. 10, 2013

Subject: Comments to "Reconsideration of Final Rule New Source Performance Standards and Emission Guidelines for Commercial and Industrial Solid Waste Incineration Units" (76 Fed. Reg. 80,452 (December 23, 2011)

To Whom It May Concern:

Dr. Adam Taylor and Dr. Jeff Lloyd, members of the International Research Group on Wood Protection, are pleased to have this opportunity to submit comments to the U.S. Environmental Protection Agency's (EPA's) "Reconsideration of the Final Rule for New Source Performance Standards and Emission Guidelines for Commercial and Industrial Solid Waste Incineration Units." As the Agency is aware, the rulemaking was recently reopened to address concerns regarding several provisions of the final new source performance standards, as well as addressing the Non-Hazardous Secondary Materials (NHSM) rule. It is this latter issue that is the focus of our comments. Specifically, and as outlined in greater detail below, we believe that the NHSM rule is counterproductive and inadvertently increases environmental and human health impacts by limiting the types of secondary materials (i.e., non-hazardous treated wood) that can be utilized as fuel.

I. BACKGROUND

Adam Taylor is an Associate Professor at the Center for Renewable Carbon at the University of Tennessee. Dr. Taylor's work includes the support of the forest products industry. His research program involves the sustainability of organic materials, including the life cycle assessment of wood products and their alternatives.

Dr. Taylor is also nominated as the Vice Chairperson of Section 5 – Sustainability and Environment of The International Research Group on Wood Protection (IRG-WP), and he is an associate editor of the *Forest Products Journal*.

Dr. Lloyd is Vice President of Research and Development for Nisus Corporation, a Tennessee-based company specializing in low toxicity chemistries, such as borates and copper naphthenate. Nisus is a champion of Green Pest Management®, which promotes earth friendly methods of pest control and preservation with non-restricted use preservatives.

Nisus Corporation is a member of the Treated Wood Council; Dr. Lloyd is a member of the Railway Tie Association, the American Wood Protection Association and the Forest Products Society. He has also been the Vice President of IRG-WP for the last three years and will assume the Presidency this coming June.

IRG-WP focuses on the latest developments in wood products protection and sustainability by providing the opportunity to develop and foster interaction between scientists and other interested people from all over the world. IRG-WP does this principally through its annual and regional conferences as well as by working with different bodies active in the field. Since its inception in 1969, IRG-WP has grown to more than 350 members representing over 50 countries.

Below are our detailed comments to EPA's proposed rule amending the NHSM rule.

II. ANALYSIS

A. EPA's Proposal Has Adverse Environmental and Economic Consequences

As currently proposed, EPA's NHSM rule would establish a presumption that any treated wood or wood products are solid wastes, thus precluding their use as a fuel source unless onerous and time-consuming processes were followed to exempt such products. This change would have significant adverse effects to not only existing business concerns, but to the environment as well. Specifically, wood and treated wood are used in a variety of applications such as rail ties and utility/transmission poles because of their high utility and low environmental impact. Part of the favorable ecological profile is the ability to use wood components as a fuel after primary use (Smith & McIntyre, 2011). Generation of heat used in power generation and other suitable thermal uses is an important part of the industry today and is part of the overall desirability of this product.

Allowing multiple uses of this renewable resource reduces fossil fuel use and greenhouse gas emissions. The use of treated wood lowers greenhouse gas emission over the product lifecycle by capturing carbon dioxide during tree growth, storing it during the use phase(s) and providing an offset to fossil fuels when it is burned during disposal. EPA's proposal will discourage the use of treated wood by labeling products taken out of service as "solid waste." Boiler operators will be forced to abandon treated wood as a fuel rather than deal with the administrative hurdles of reversing the presumptive characterization. The loss of treated wood biomass will be offset by increased use of fossil fuels. In addition to providing a carbon-neutral energy source of low carbon footprint (Bergman *et al.*, 2012), treated wood fuel results in reduced emissions of sulfur and nitrogen oxides and ash. Along with removing a less environmentally impactful fuel from the market, EPA's proposal will have the unintended consequence of causing a large increase in the quantity of treated wood products going to landfills. For example, approximately 25 million ties (100 million cubic feet of wood) are replaced each year (after a completion of 20 to 50 years of service in track), and there is a significant volume of wood from utility poles. By diverting these products away from combustion facilities due to their new status as "solid waste," EPA will incentivize industry to avoid legitimate and environmentally-appropriate secondary uses of treated wood products and instead dispose of the wood – specifically to land disposal, and the corresponding green-house gas emission through methane production. Such practices will put a strain on existing landfill resources and raise costs to the railway and utility sectors, as well as create further environmental impacts. Any increase in costs will only be passed on, resulting in higher costs for rail transportation and electricity distribution in an economy that can ill afford significant increases in costs of operation and distribution for the movement of goods and transmission of power.

But the greatest potential for **environmental harm** from the proposed rule change is the substitution of non-wood materials (i.e., steel and steel-reinforced concrete) for treated wood products. The life cycle environmental impacts of treated wood are much less than those of steel and steel-reinforced concrete (Smith and McIntyre 2011). By increasing the costs of management of treated wood, EPA's proposed change will encourage the use of non-wood alternatives, resulting in large, very negative, unintended environmental impacts.

EPA's proposal will also have adverse financial impacts. The United States is the largest user and producer of wood products in the world. The wood and forest products industry is an important part of the U.S. rural economy in terms of capital and employment, and treated wood is a vital component of the lumber and timber sectors, providing an outlet for otherwise low-value logs and log heart-centers. Reducing the use of treated wood will significantly reduce the demand for wood products resulting in job loss in this sector.

In summary, treated wood is a highly functional, cost-competitive, renewable and low environmental impact option for the utility and railway industry. Use of treated wood in combustion is a key component of the product lifecycle and provides an important source of clean, bio-based energy. Labeling spent treated wood as solid waste threatens to disrupt the current use and management of treated wood, which will reduce biofuel usage, increase landfill burdens, reduce demand for wooden products and increase substitution of non-renewable, energy-intensive, environment-damaging alternatives. We implore EPA to avoid these unintended consequences and to change the final rule to allow non-hazardous treated wood to be used as a boiler fuel.

Yours faithfully,

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References and Appendices

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IRG/WP 11-50282

THE INTERNATIONAL RESEARCH GROUP ON WOOD PROTECTION

Section 5 Sustainability and Environment

Life Cycle Assessment Comparison of Treated Wood to Alternate Materials – Overview, Results and Lessons

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Life Cycle Assessment Comparisons of Treated Wood Products to Alternate Materials – Overview, Results and Lessons

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ABSTRACT

Life Cycle Assessment (LCA) has proven useful in documenting the "green" benefits of various treated products compared to the commonly used alternates. To date, six LCA comparisons have been done or are nearing completion using ISO14040 and 14044 principles and data from US EPA databases. In almost all cases, the impact indicators for treated wood products show considerably smaller adverse effects on the environment than the comparators. In some cases, there is more than a 10-fold difference favouring the treated wood. This paper briefly reviews the methodology of preparing LCAs and provides an overview of the comparative LCA results, particularly of borate treated lumber to galvanized steel framing.

Keywords: Life Cycle Assessment, environmental impact indicators, treated wood products, borate, pentachlorophenol

1. INTRODUCTION

1.1 "Green" movement

Concern has grown over recent decades about the state of "the environment". As a result, significant advances in environmental issues have been made, such as reductions in vehicle emissions, wastewater treatment, and reduced industrial pollution. However, public fears and perceptions of global warming, environmentally toxic chemical releases, resource depletion, and human health impacts have continued to grow. Consumers now want to buy, and manufacturers want to be viewed as producers of, environmentally friendly or "green" products. How can "greenness" be measured?

1.2 LCA process

Life cycle assessment (LCA) has evolved over the last few decades to be a rigorous, transparent, and systematic process to measure the environmental impacts associated with products. Products of equivalent use and with lower environmental impacts are greener than those with higher impacts. LCA accomplishes this by first making an inventory (life cycle inventory or LCI) of the environmental inputs and outputs related to the manufacture, use, and end of life disposition of products. Then, the LCI results are used to assess potential indicators of environmental impact. Finally, the results are interpreted for significance and "apples to apples" comparison of different products that provide approximately equal services can be done.

While this three step approach is relatively straight forward in theory, the procedure is complicated. The inventory requires an understanding of the manufacturing processes, the required raw material inputs, energy quantities and types, product use life and maintenance processes, and processes related to ultimate product end-of-life fates. The assessment requires that the inventory data are used to calculate potential impacts of widely diverse resources or emissions. For example, one may have to equate oil, natural gas, and electric use with fossil fuel or calculate equivalent Green House Gas (GHG) emissions from manufacturing processes and products placed in landfills for disposal. Finally, the interpretation needs to answer the question, "What does all this mean?"

1.3 Treated wood position

So far, treated wood products have not fared well in the "greenness" debate. The public has a negative view of cutting trees to make products. The perception is made worse when the wood product is chemically treated. The legacy of old wood preserving plants as hazardous waste or Superfund sites further degrades perceptions. The result is that some in the public are now willing to pay more than they would for treated wood for non-wood products that are perceived as more green, such as wood plastic composite "lumber," for home decks. Companies, such as utilities, contractors, and railroads, are driven by customers and stockholders to utilize materials that they view as environmentally friendly.

The treated wood industry knows that it utilizes wood products produced sustainably in North America and other regions of the world. The industry also knows that preservative treatment results in products with long service lives that economically and environmentally meet the consumers' needs. However, it has not had the tools to adequately make the "green" case to American consumers.

1.4 TWC, AquAeTer, and LCA project

The Treated Wood Council (TWC) is an international trade association serving the treated wood industry with more than 440 member organizations. The TWC members recognized the need to better document and communicate the environmental advantages or greenness of treated wood products overall and in relation to other non-wood products.

Accordingly, in early 2008, the TWC contracted with AquAeTer to complete a series of LCA reports of treated wood products. AquAeTer, Inc. is an environmental consulting company with a long history with and unique knowledge of the wood preserving industry. The intended audiences for the LCA include: 1) members of the TWC; 2) building officials; 3) government regulators; 4) "green building" advocates; 5) life cycle inventory databases for building products; and 6) end product consumers.

2. TREATED WOOD LCAs OVERVIEW

The LCAs of treated wood cover the full cradle-to-grave life cycle of the treated wood and alternate non-wood products. Representative treated wood products (preservative, wood species, end use) were selected in cooperation with the TWC to cover the major segments of the treated wood industry. The LCAs are comparative, meaning inventories and assessment impacts are calculated in simplified or screening format for the representative non-wood products that compete for the same end uses as the treated wood products. The reports were done in accordance with established international standards for LCAs, including ISO 14040 and 14044.

Complete separate LCA reports have been or are being prepared for each of the following treated wood and comparison products:

- Borate-treated lumber to galvanized steel framing

- Alkaline copper quaternary- (ACQ-) treated lumber to wood-plastic composite (WPC) decking
- Pentachlorophenol-treated wood utility poles to galvanized steel and concrete utility distribution poles
- Creosote-treated railroad sleepers (crossties) to concrete and plastic railroad sleepers (crossties)
- Chromated copper arsenate- (CCA-) treated wood piling to concrete, galvanized steel, and plastic marine piling
- CCA-treated wood to galvanized steel highway guardrail posts

Primary inventory data for treated wood processes are based on surveys completed by wood preserving plants that produce the above commodities. AquAeTer compiled this process data. Most other inventory data are obtained from published sources. One very significant source of published information is the U.S. Department of Energy National Renewable Energy Laboratory (NREL) Life Cycle Inventory Database. (This data base is available at http://www.nrel.gov/lci/).

The inventory data are assembled in spreadsheets in which mathematical relationships are used to develop the cradle-to-grave model of inputs and outputs for each life stage of each product. Figure 1 provides a typical life cycle diagram of a treated wood product, in this case, for borate treated lumber.

In each LCA report, the assessment phase includes a wide range of impact indicators potentially affecting impact categories (in parentheses) and includes:

- Greenhouse gas (GHG) anthropogenic emissions (Global warming)
- Net (biogenic and anthropogenic) GHG emissions (Global warming)
- Fossil fuel use (Resource depletion)
- Acid gas forming emissions (Acidification)
- Smog forming emissions (Photochemical smog)
- Water use (Resource depletion)
- Nutrient emissions (Eutrophication)
- Ecologically toxic air emissions (Ecotoxicity)
- Ecologically toxic water releases (Ecotoxicity)
- Total energy input (a general measure of overall resource intensity)

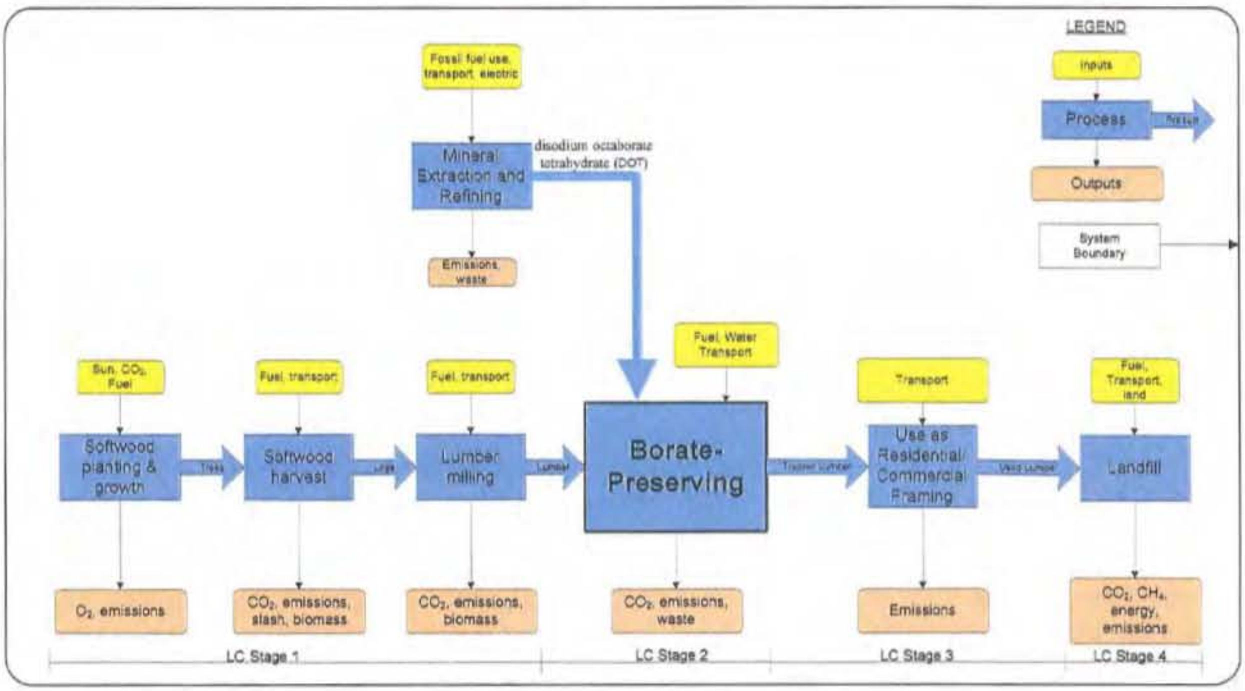


Figure 1-Life Cycle Diagram for Borate Treated Lumber

Most of the impact indicators use weighting factors that relate the potency of constituents to a single chemical. For example, for GHG emissions, carbon dioxide has a value of one and methane a value of 21. Thus, for the GHG total, kilograms (2.2 pounds) of carbon dioxide are added to 21 times the kilograms (2.2 pounds) of methane and reported as kilograms (2.2 pounds) of carbon dioxide equivalent (kg CO_2-eq.)

Weighting factors from the EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) model are used to calculate GHG emissions, acidification, smog, eutrophication, and ecotoxicity indicators. The TRACI spreadsheet model is a compilation by the U.S. EPA that includes hundreds of specific chemicals and lists impact potency values for various environmental impacts (TRACI, 2002).

Energy and fossil fuel are converted to heat value in kilojoules (or British thermal units (BTUs)) and water is simply reported in liters (or gallons). Impact indicator values are then reported as units of impact per unit of product per year. For example, in the LCA project for borate treated lumber, GHG calculations use TRACI factors and other conversions to report GHG as equivalent kilograms of CO_2 released per 30.5 lineal metres (100 lineal feet) of exterior wall per year of use.

Results may vary based on various choices made through the life cycle of each product. Each LCA is based on a "baseline" set of conditions and assumptions intended as a best estimate of current or typical practices. The choices include items such as type of energy used (biomass or natural gas for heat), end-of-life disposal or recycling options, and input materials (virgin versus post-consumer plastic). Sensitivity analysis is used to measure the changes to impact indicators that result from selected choices.

Each LCA report includes an interpretation section that determines normalized impact indicator values, provides comparisons between treated wood and alternate products, evaluates the relative significance of impacts, and makes conclusions. The impact indicators are normalized to make the results between products comparable, such as for each 30.5 lineal metres (100 lineal feet) of wall framing or each 1.6 km (1 mile) for railroad track sleepers (crossties) per year of use. To further assist understanding, normalized results are compared to national impact indicators, such as total U.S. fossil fuel use or average family fossil fuel use.

To date, six LCA reports have been prepared and are in various stages of review. Two LCA reports have been published and one accepted for publication in peer reviewed journals as legitimate, scientific sources of information:

Bolin, C A, Smith, S T, 2011a, Life Cycle Assessment of Borate-Treated Lumber with Comparison to Galvanized Steel Framing.

Bolin, C A, Smith, S T, 2011b. Life Cycle Assessment of ACQ-Treated Lumber with Comparison to Wood Plastic Composite Decking.

Bolin, C A, Smith S T, 2011c. Life Cycle Assessment of Pentachlorophenol-Treated Wooden Utility Poles with Comparisons to Steel and Concrete Utility Poles.

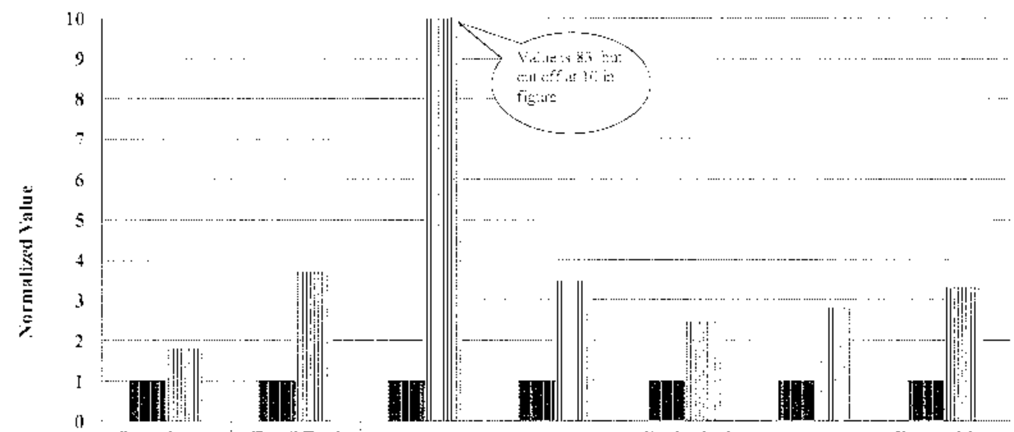
3. LCA PRELIMINARY RESULTS

3.1 Comparative Results Overview

Not all of the LCA reports are complete, so where source information is not yet published, any unpublished information is presented as a discussion of generic, preliminary results.

In general, the LCA results document significant advantages to treated wood over the competing non-wood products. Compared to the alternative non-wood products, use of treated wood products generally results in lower cradle-to-grave:

- Total energy
- Fossil fuel
- Anthropogenic GHG
- Acid forming emissions
- Smog forming emissions
- Ecotoxic air emissions



	Greenhouse Gases	Fossil Fuel Use	Water Use	Acid Rain	Ecological Impact	Smog	Eutrophication
Borate Lumber	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Galv. Steel Framing	1.8	3.7	83	3.5	2.5	2.8	3.3

Figure 2. Indicators for Borate-Treated and Galvanized Steel Framing Normalized to Borate = 1.0

The LCA for borate-treated lumber considers residential construction in areas subject to termite attack to framing members. Both borate-treated lumber and galvanized steel framing resist termite attack. Figure 2 provides a graphic comparison of borate-treated lumber, normalized to equal 1.0, and relative values for galvanized steel framing.

For all products assessed thus far, treated wood products use less fossil fuel in comparison to their non-wood alternatives. The magnitude of the variance differs, but the trend is clear. Approximate fossil fuel use for treated wood products ranges from as little as 30% less up to 30 times less than alternative products.

Treated wood products do not necessarily offer the lowest impact for all indicators. For eutrophication, results appear to be approximately equal for several of the product comparisons.

3.2 Significance Overview

The comparative results described above are informative, but don't answer the question; Do the differences matter? A dime is worth ten times more than a penny, but neither alone will affect someone's status of living; so neither is individually significant.

In the LCAs, the impact indicator values for treated wood and alternate products are compared to national or per typical family (of three people) total impacts that are based on total annual use or releases in the U.S. Environmental releases are evaluated using the TRACI model to determine national impact indicator values and divided by the U.S. population for per capita values (Bare et al. 2006). A similar approach is used for energy, fossil fuel, and water, using published national use values from the U.S. Energy Information Administration and U.S. Geologic Survey.

The relative significance is the percentage of the product impact indicator value to the "per family" or "national total values". A dime represents 0.0002% of an annual income of $50,000 or one part in 500,000, which by most measures is not significant. However, $5,000 represents 10% of the $50,000 income and by most measures is significant. The national normalization to per cent of national or family impacts helps to illustrate values and differences of significance.

Different means of national normalization were used as appropriate for different products. In Table 1, the value for each product indicator is the percentage that indicator would be increased for a household that installed borate-treated lumber or galvanized steel framing in exterior walls during construction of their typically-sized home compared to building with untreated lumber. In this case, values greater that 0.1% (one in one-thousand) would be considered significant. Thus, the treated product may offer lower impact indicators, but neither it nor the alternate would cause a significant increase (more than 0.1%) for a household's footprint.

Table 1-National Normalized Indicators Borate-Treated and Galvanizes Steel Framing per Family Home per Year

Product	Total Energy Value	Greenhouse Gas Emissions	Fossil Fuel Use	Water Use	Acid Rain Potential	Ecological Impact	Smog Potential	Eutrophication Potential
Borate-treated lumber	0.0097%	0.034%	0.010%	0.00016%	0.013%	0.011%	0.0076%	0.0057%
Galvanized steel framing	0.035%	0.061%	0.038%	0.014%	0.045%	0.026%	0.021%	0.019%
US Family Average	100%	100%	100%	100%	100%	100%	100%	100%

In contrast, for a different end use product, Product A, the treated product may offer lower impact indicators, and the alternate or both products may cause a significant increase (more than 0.1%) for a household's footprint in one or more indicators.

Thus by this evaluation, considering a project using borate-treated lumber framing, the greener choice is treated wood, but the "footprint" is not significant for either material. However, for the choice of using Product A for a project, treated wood may be greener and also offer a significantly smaller "footprint" compared to the alternate.

Perspective regarding the significance of industrial products such as utility poles or railroad ties includes additional challenges. Impact per household or per capita is not applicable. Instead, the LCA impact indicators are normalized to compare the annual national impacts of the industrial product category (assuming all in that category are of the same material, such as all wood distribution poles are either pentachlorophenol-treated, concrete, or steel) to the overall total U.S. national impact values. For these products, we have judged impacts to be potentially significant if more than 0.01% (one in ten thousand) of the national values.

For pentachlorophenol-treated utility poles, representing industrial products in this paper, the results are shown in Table 2. Indicators considered "significant" at more than 0.01% are shown in **bold font**. Only the smog indicator is significant for wood poles, but of eight indicators, seven for concrete and six for galvanized steel are significant in relation to U.S. national energy or environmental measures. In this case, the magnitude of all impacts, other than smog, is significantly less for the treated wood product than for the alternate products.

Table 2-National Normalized Indicators for an Pentachlorophenol-Treated and Alternate Utility Poles

Industrial Product	Total Energy Value	GHG Emis-sions	Fossil Fuel Use	Acid Rain Potential	Water Use	Smog	Eutro-phication	Ecotox-icity Air
Pentachlorophenol-Treated Wood	0.006%	-0.015%	-0.001%	-0.015%	0.0001%	**0.066%**	0.007%	-0.012%
Concrete	**0.036%**	**0.045%**	**0.040%**	**0.043%**	0.0003%	**0.027%**	**0.022%**	**0.092%**
Galvanized Steel	**0.021%**	**0.024%**	**0.022%**	**0.031%**	0.0002%	**0.012%**	0.008%	**0.028%**

Note that LCA efforts are continuing. The results of Table 2 are generally similar to findings for other industrial products, but are not intended to imply that treated wood impacts are lower for every indicator for every product. Negative values indicate a net life-cycle reduction in the indicators, as discussed below in 4.2.

4. LESSONS

4.1 Carbon balance and Net GHG

GHG emissions, used as an impact indicator for manufactured products, consider human caused (anthropogenic) emissions of carbon dioxide, methane, and other GHGs. When comparing the cradle-to-grave life cycles of wood products to products manufactured of fossil or mined resources, anthropogenic GHG emissions tell only part of the GHG story. Wood products begin their life cycles when trees are planted and growth begins. Tree growth utilizes solar energy and the process of photosynthesis to remove carbon dioxide from the atmosphere and convert that into wood mass. Thus, if all GHGs (biogenic and anthropogenic) are considered, the wood product begins life with a credit of GHG emissions. By analogy, one could say that a wood product begins life with money (carbon credits) in its saving account which is then later spent as the product goes through life. Concrete or steel products, in contrast, begin life with no credits in the bank and must borrow credits throughout their life cycles.

As wood products complete life cycles, the material may be recycled for energy recovery. By this means, the carbon stored in the wood mass is returned to the atmosphere as biogenic carbon dioxide and the solar energy stored in the wood is beneficially recovered, offsetting the use of an energy-equivalent amount of fossil fuel, such as oil or coal. The biogenic energy offset results in further carbon credits to the wood product account. When steel products, for example, are recycled, some of the GHG emissions "money" taken for manufacturing is credited back into the steel products account, thus repaying part of the amount withdrawn. Only wood products have the potential to complete their life cycles with a net GHG credit remaining in their accounts.

LCA provides a more complete understanding of wood products GHG impacts when both anthropogenic and net GHG emissions balances are considered.

4.2 Recycling for energy

A recurring theme in the treated wood LCAs is that the treated wood product life-cycle impacts can be significantly reduced if more of the wood is recycled for energy production as an end-of-life management option. Recycling for energy results in credits for avoided fossil fuel use and reduces wood disposal in landfills resulting in less methane emissions.

In Figure 3, the flux of GHGs is plotted against approximate years into the life cycle for pentachlorophenol-treated utility poles, an industrial wood product. Between years 0 and 40, the tree grows and removes carbon dioxide from the atmosphere, resulting in a credit (or negative value) of approximately 1,030 kg CO_2-eq/ m^3 (64,000 lb CO_2-eq/Mcf). Biomass and other fuel is used in year 40 to harvest, mill, and treat the wood product resulting in emission of approximately 260 kg-CO_2-eq/m^3 (16,000 lb CO_2-eq/Mcf) for a remaining credit of 770 kg-CO_2-eq/m^3 (48,000 lb CO2-eq/Mcf). Release of oil and a little decay of wood during use emit CO_2 and reduce the credit to approximately 690 kg (43,000 lb) during the approximate 60 year use life.

Following use, different end-of-life management choices result in different GHG outcomes. Sensitivity analysis is used to evaluate three sets of end-of-life choices, as shown in the Table 3. Note that half the volume reused is assumed to ultimately be landfilled, so the actual amount landfilled is larger than the values shown.

Table3-Sensitivity Scenarios for Fates

Fate Scenarios	Baseline	More Energy Recycling	More Landfill
Disposition after Removal	Fraction of material to each management option		
Reuse by owners	5%	5%	5%
Reuse for fence or landscaping	45%	**15%**	**15%**
Disposal in landfills	30%	**0%**	**80%**
Disposal in cogeneration	20%	**80%**	**0%**

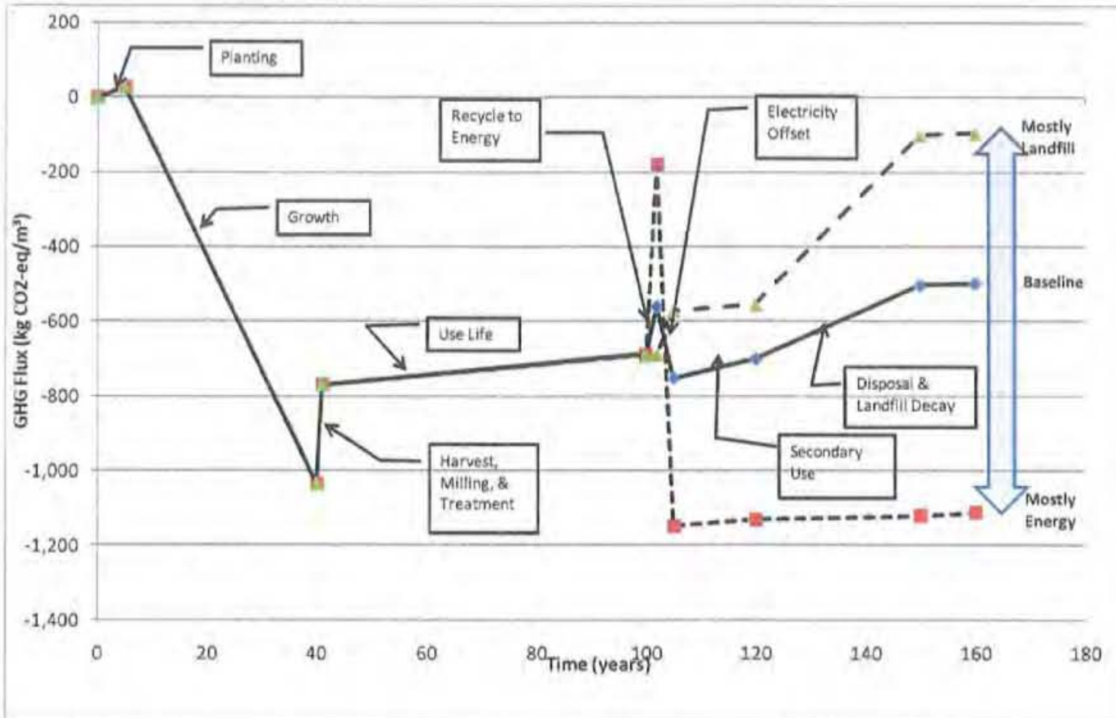


Figure 3. GHG Flux for Pentachlorophenol-Treated Wood Utility Poles Life Cycle

The solid line of the figure shows the flux for the LCA baseline scenario. The scenario emphasizing more recycling for energy is shown with the short-dashed line and the final fate scenario emphasizing more landfill disposal is shown by the long-dashed line. The net GHG emissions for the product life cycle range from -96 for the more landfill scenario to -500 for the baseline to -1,100 kg-CO_2-eq/m^3 (6,000, -31,000, and -69,000 lb CO2-eq/Mcf, respectively) for the more recycling for energy scenario. The difference between the two scenarios is highlighted by the large arrow. The final fate scenario involving maximum energy recovery results in GHG emissions reduction equal to the emissions of combusting more than 2.3 barrels[1] of oil for each m^3 (0.16 Mcf) of wood product managed.

Similar results may be obtained for any of the treated wood products. It is clearly advantageous for the treated wood industry to encourage recycling of products to energy recovery following use.

4.3 LCA Results Communications Challenge

The treated wood industry has a great story to tell about the cradle-to-grave "green" qualities of its products. However, to do so simply, accurately, and understandably is challenging.

Additionally, these environmental indicators and their significance need to be balanced with other important product characteristics, such as initial and life-cycle costs, aesthetics, durability, ease of installation and maintenance, safety, and other factors.

[1] CO2 difference is 11,100-100 = 1,000 kg-CO2/m^3. Divide by 432 kg CO2 for each barrel of oil. Result is ~2.3 bbl oil of equivalent CO2 reduced for each m^3 of wood managed at scenario levels.

Completion and publication of these LCA reports will be the first step in the overall project of informing public policy makers, customers and the public about the "green" qualities of treated wood products.

5. REFERENCES

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CARBON IMPACTS OF WOOD PRODUCTS

The release of carbon dioxide (CO_2) during a product's manufacture and use is sometimes referred to as its 'carbon footprint.' Coal, oil, natural gas and wood all contain solid carbon that becomes CO_2 gas when the material is burned for energy. Because CO_2 release contributes to climate change, and because of the need to conserve our energy resources, there is a desire to reduce the footprint of products and to choose products with a smaller carbon footprint.

The carbon footprint of a product can be calculated by measuring and categorizing all of the energy inputs.

Calculating the carbon footprint of wood products requires special consideration. Wood manufacturing uses a lot of bio-energy, the products store carbon, and wood products manufacturing is energy efficient. For these reasons, most wood products have negative carbon footprints – their use actually results in net carbon storage. The carbon impacts of wood products can be measured using the simple formula explained below:

The Wood Product Carbon Impact Equation

$$A-B-C-D = E$$

A
Manufacturing Carbon

Manufacturing uses energy and most energy production results in carbon dioxide release.

B
Bio-fuel

Wood residues are often burned for energy during the manufacture of wood products. Because the carbon dioxide released when this wood is burning was recently absorbed from the atmosphere by the growing tree (during photosynthesis), this fuel is considered to be 'carbon neutral'. This 'bio-fuel' usage reduces the carbon footprint of wood products.

C
Carbon Storage

Carbon dioxide (CO_2) is absorbed from the atmosphere during photosynthesis by the growing tree. This carbon is converted to wood, bark and other parts of the tree, which are about ½ carbon by weight. If the tree rots or burns, the solid carbon in the wood is released again to the atmosphere as carbon dioxide gas. However, as long a wood product is in service, it is keeping potential carbon dioxide gas out of the atmosphere. This 'carbon storage' of wood products reduces the carbon footprint of wood products.

D
Substitution

There are alternatives to wood products for most applications. However, almost all of these non-wood alternatives require more energy for their manufacture, and the energy used is almost entirely fossil carbon – carbon that has been stored in coal, oil and natural gas for millions of years. When fossil carbon energy sources are used they contribute to the carbon footprint. If a wood product with a smaller fossil carbon footprint is used in place of a non-wood alternative, we can consider this to be a savings of carbon. This 'substitution effect' reduces the carbon footprint of wood products.

E
Total Carbon Footprint or Carbon Credit

The bio-fuel (B), carbon storage (C) and substitution (D) effects reduce the carbon footprint of wood products. In fact, these effects together are almost always greater than the manufacturing carbon (A), so the overall carbon effect of using wood products is a negative carbon footprint (i.e. carbon credit or storage). Thus using wood products can help us to reduce contributions to climate change and conserve energy resources.

Carbon Impacts of Wood Products			A	B	C	D		A-B-C-D = E
Product	Units & Notes		Carbon[1] released during manufacture	Carbon from bio-fuel used in manufacturing (wood energy)	Carbon stored in the wood product	Substitution carbon (fossil carbon emissions avoided by using the wood instead of an alternative)	Alternative	TOTAL CARBON FOOTPRINT (Negative values represent a carbon credit)
Hardwood lumber	One board foot (12"x12"x1")	NE/NC region	0.9	0.6	1.8	2.6	PVC (plastic) molding	-4.2
		Southeast region	1.1	0.8	1.8	2.6		-4.1
Softwood lumber	One 2x4 'stud'	NE/NC region	1.8	1.2	6.6	7.0	steel stud	-13.0
		Southeast region	3.9	3.3	8.4	7.0		-14.9
Hardwood flooring	One square foot	Solid strip flooring	1.1	0.7	2.1	0.0	vinyl	-1.8
		Engineered wood	1.0	0.5	1.1	-0.1		-0.5
Doors	One door	Solid wood	46.5	29.4	100.4	228.1	steel door	-311.5
Decking	One deck board	ACQ- treated pine	5.2	1.7	16.1	11.9	wood-plastic composite	-24.5
Siding	100 square feet	Western redcedar	37.7	6.0	77.7	20.4	vinyl	-66.3
Utility poles	One 45' pole	Pentachlorophenol-treated wood	454.5	430.9	1160.4	1377.1	concrete pole	-2513.9
OSB	One 4' x 8' sheet, 3/8" thick	Southeast region	18.0	10.7	34.7	-	n/a	-26.3
Plywood	One 4' x 8' sheet, 3/8" thick	PNW region	5.7	4.1	25.5	-	n/a	-23.9
		Southeast region	10.1	6.5	30.9	-	n/a	-27.3
I-joists	One 16' long, 10" deep joist	PNW region	22.8	18.9	63.9	56.4	steel joist	-116.3
		Southeast region	33.0	22.9	80.0	55.0		-125.0

[1] All "carbon" values are kilograms of CO_2. To convert from CO_2 to elemental carbon, muliply by 0.27. For comparison, a car produces 8.8 kg of CO_2 when it burns one gallon of gasoline.

These data are compiled from Life Cycle Assessments (LCA) of the various products. LCA measures the all of the inputs and emissions from making and using a product and then estimates the total environmental impact in various categories. One important category is the carbon impact of the energy used, which can be separated into fossil (coal, oil and natural gas) and biomass (e.g. wood) components. LCA are conducted according to internationally accepted standards and the data are reviewed by experts.

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