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## **Treated Wood Utility Poles Offer Environmental Life Cycle Advantages Compared to Steel, Concrete, and FRC**

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### **Background**

AquAeTer, Inc., an environmental consulting company, completed a series of Life Cycle Assessments (LCAs) of treated wood products with comparisons to alternative, non-wood products for the Treated Wood Council (TWC). The TWC represents the U.S. wood preserving industry. One LCA was completed for Treated Wood Utility Poles. The full report is available from the TWC. An article summarizing those results has been published in a peer reviewed journal.<sup>1</sup> A supplemental LCA of poles was more recently completed that included comparison to fiber reinforced composite (FRC) poles. This paper provides a brief overview of the utility poles LCA process and findings.

### **Life Cycle Inventory**

A cradle to grave inventory of inputs and outputs required to grow, manufacture, treat, use, and dispose of pentachlorophenol-treated utility poles was prepared. Published data, a survey of treaters, and professional judgment were used. Similar cradle to grave inventories were completed for the alternative non-wood products of galvanized steel, prestressed concrete, and FRC utility poles. Industry historic data strongly support an average service life of wood utility poles of at least 60 years. Equal service life was assumed for the other products, although historic data is not yet available for reliable predictions.

### **Life Cycle Assessment**

The inventory data for all products was used to calculate standardized environmental impact and energy indicators. The impact indicators, model explanation, and impact category of each are listed in Table 1. Each impact indicator is a measure of an aspect of potential impact. The LCA does not make value judgments about the impact indicators, meaning that no one indicator is given more or less value than any of the others. All are presented as equals. The units in which indicator values are reported are generally not comparable, such as million BTU of energy use cannot be compared to equivalent pounds of 2,4-D pesticide release.

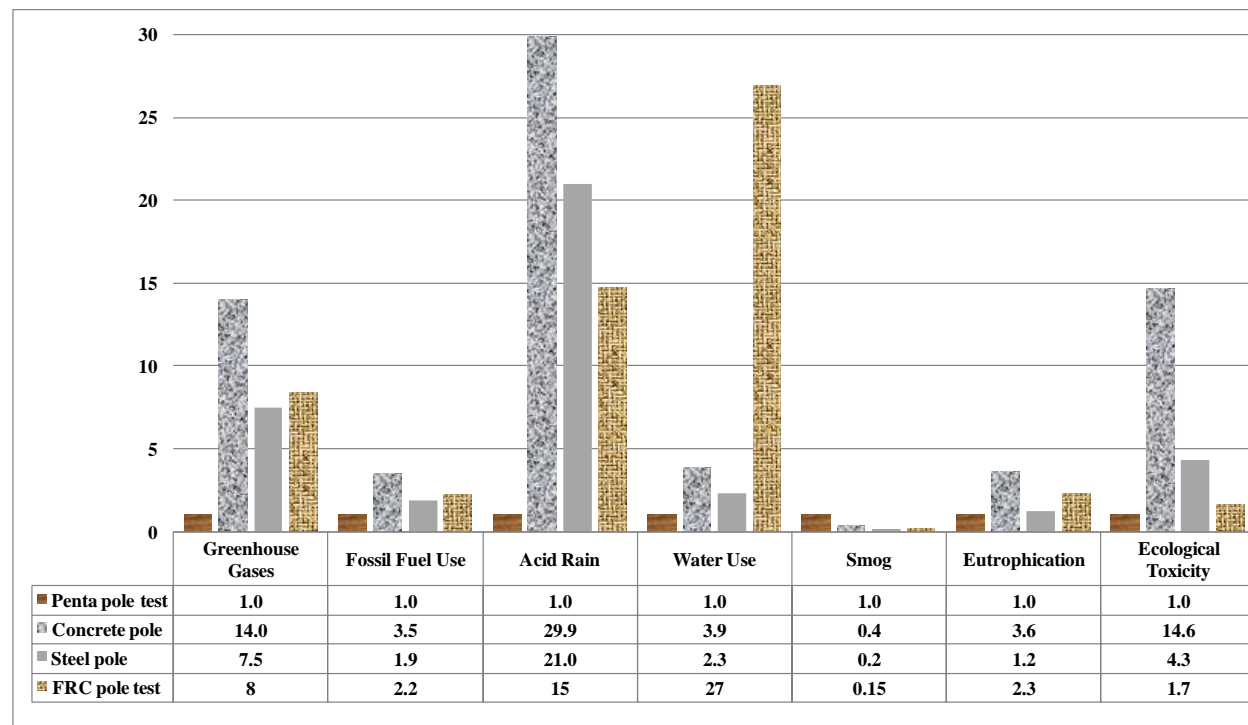
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<sup>1</sup> Bolin and Smith, 2011. Life Cycle Assessment of Pentachlorophenol-Treated Wooden Utility Poles with Comparisons to Steel and Concrete Utility Poles. Renewable and Sustainable Energy Reviews. Volume 15, June 2011, pp 2475-2486.

Impact Indicator	Characterization Model	Impact Category
Green house gas (GHG) emissions	Calculate total equivalent anthropogenic CO <sub>2</sub> emissions for CO <sub>2</sub> , methane, and nitrous oxide per functional unit.	Global warming
Fossil fuel usage	Total amount of fossil fuel, based on BTU value, used in product life cycle per functional unit.	Resource depletion
Releases to air potentially resulting in acid rain (acidification)	Calculate total hydrogen ion (H <sup>+</sup> ) equivalent for released sulfur oxides, nitrogen oxides, hydrochloric acid, and ammonia using factors from TRACI (2002). Acidification value is in units of H <sup>+</sup> mole-eq per functional unit.	Acidification
Releases with potential ecological toxicity	Use the impact factors from TRACI (2002) to calculate the ecotoxicity potential of releases in units of lbs 2,4-D-eq per functional unit.	Ecotoxicity
Releases to air potentially resulting in smog	Use the impact factors from TRACI (2002) to calculate the smog forming potential of releases in units of g NO <sub>x</sub> / m per functional unit.	Photochemical smog
Releases to air potentially resulting in eutrophication of water bodies	Use the impact factors from TRACI (2002) to calculate the eutrophication potential of releases in units of lb N-eq per functional unit.	Eutrophication
Amount of water used or consumed	Calculate total water use per functional unit.	Water use

**Table 1-Impact Indicators**

However, the impact indicator results can be normalized to facilitate comparisons between products (product normalization). In this LCA, results are normalized to the values for pentachlorophenol treated poles. Thus, for each indicator, the value for wood poles is 1.0 and others are multiples of 1.0 if higher or fractions of 1.0 if smaller. Figure 1 supports comparison between products for each indicator.



**Figure 1-Impact Indicators Normalized to Penta=1.0**

As demonstrated in Figure 1, pentachlorophenol treated poles have lower impact indicators than concrete, steel, and FRC for greenhouse gas emissions, fossil fuel use, acid rain, water use, eutrophication, and ecological impact while the smog forming emissions impact is higher for treated wood than the other products.

While differences between products is clear in Figure 1, it does not answer the question; “Do these impacts matter?” The LCA uses national normalization to provide perspective regarding the magnitude of the impacts. Total impact values are calculated for theoretical scenarios in which all wood utility poles in the U.S. uniformly of one material; pentachlorophenol treated wood, concrete, steel, or FRC. These totals for each product are divided by national total impacts, based on U.S. total emissions or usage and reported as a percentage of the U.S. totals. These results are shown in Table 2. Note that all of the values for all products are less than 0.1 percent of U.S. national values.

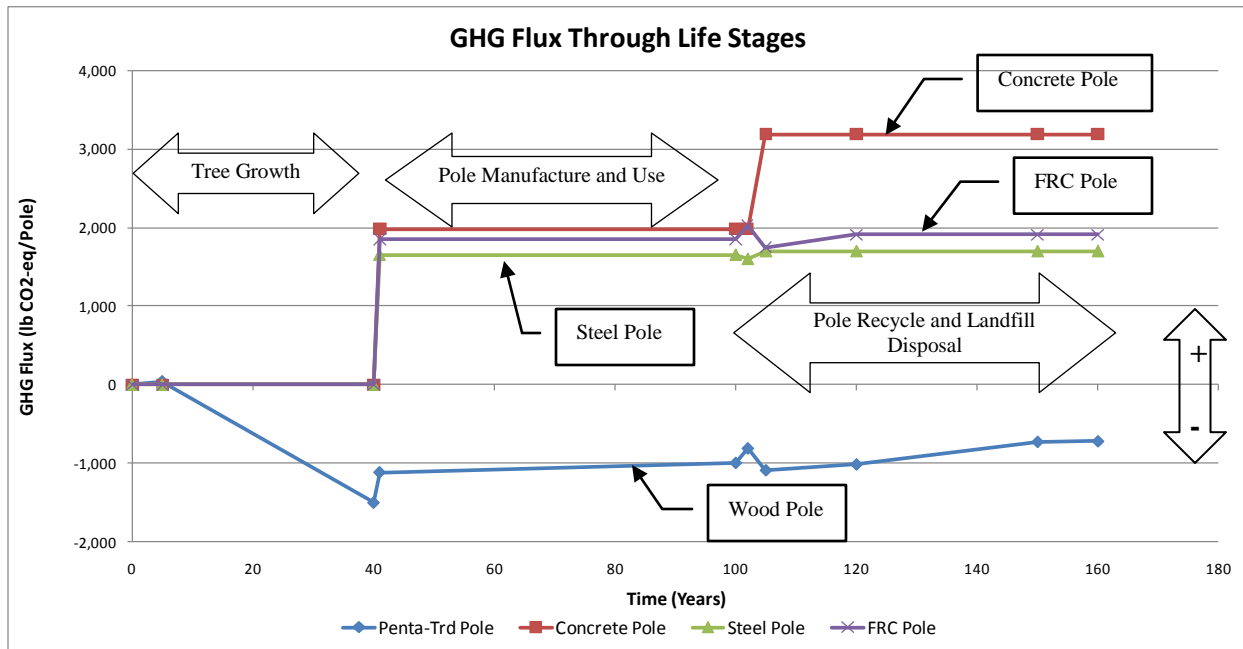
Impact Category	Fractional Impact Indicator Values of New Utility Poles (if all same type) to Total U.S. Impact Indicators				
	Penta-pole cradle-to-grave	Concrete pole cradle-to-grave	Steel pole cradle-to-grave	FRC pole cradle-to-grave	Converted Units
Total Energy Value	0.013%	0.036%	0.021%	0.023%	MMBTU
Greenhouse Gas Emissions	0.0032%	0.045%	0.024%	0.027%	lb-CO <sub>2</sub> -eq
Fossil Fuel Use	0.011%	0.040%	0.021%	0.026%	MMBTU
Acid Rain Potential	0.0014%	0.043%	0.030%	0.021%	lb-mole H <sup>+</sup>
Water Use	0.000081%	0.00032%	0.00019%	0.0022%	gal/yr
Smog	0.068%	0.027%	0.012%	0.012%	g NO <sub>x</sub> -eq/m
Eutrophication	0.0061%	0.022%	0.0073%	0.0073%	lb-N-eq
Ecotoxicity Air	0.0063%	0.092%	0.027%	0.0105%	lb-2,4-D-eq

**Table 2-Nationally Normalized Impact Indicators**

## Carbon Cycle Impact

The LCA provided a means to evaluation carbon uptake and emissions of different products as well as under alternate management scenarios. Unlike other products, wood products remove carbon dioxide from the atmosphere as the trees grow. Portions of this carbon are returned to the atmosphere as wood decays or is burned. Carbon is stored in the product throughout its service life. Some may be stored in landfills when the wood is disposed, but much of this sequestration is offset by release of methane, 21 times more potent in warming potential than carbon dioxide, resulting from anaerobic decay that typically occurs in landfills.

Only wood products start their life cycles by using carbon that is removed from the atmosphere. The first stage of production of non-wood pole products is the extraction of resources, such as oil, coal, limestone, or silica sand, and the use of mostly fossil energy to convert these into products. Following the use stage, wood poles may be recycled for energy production, further offsetting fossil energy use. Recycling non-wood poles may reduce the life-cycle inputs for each successive product generation, but cannot reverse the slope of more CO<sub>2</sub> emissions over time. The resulting GHG flux trends, or changes through use of or emission to the atmosphere of CO<sub>2</sub>-eq, through the life stages of the pole products is strikingly different. This is clearly evident in Figure 2 in which the GHG flux amounts of the poles life stages are shown.



**Figure 2-GHG Flux by Pole Type and Stage**

Figure 3 is similar to Figure 2, but focuses instead on the optional use of wood pole related biomass for energy production. Units are pounds of carbon dioxide equivalent per average utility pole (lb CO<sub>2</sub>-eq/pole). Values are calculated for current management practice and for two alternative scenarios, maximizing use of the wood as fuel for energy production (mostly energy) and maximizing landfill disposal (mostly landfill).

The lesson of Figure 3 is that how biomass materials are used or disposed, particularly related to end of life management, makes a great deal of difference to the overall life cycle energy and GHG impacts. Even under the mostly landfill scenario, the net life cycle GHG emissions are a negative 140 lb CO<sub>2</sub>-eq/pole. But under the mostly energy scenario, this improves to a negative 1,610. Assuming poles last on average 75 years and 132 million are in service, approximately 1.8 million poles will be replaced annually. Applying the difference between landfill and energy scenarios means that the GHG emissions attributable to approximately 55,000 U.S. citizens (0.02% of U.S. CO<sub>2</sub>-eq emissions) could be offset by maximizing recycling of wood for energy rather than disposing it in landfills. Thus, using treated wood utility poles and maximizing end of life recycling for energy together reduces atmospheric GHG concentrations, but all other non-wood utility pole products result in increased GHG concentrations.

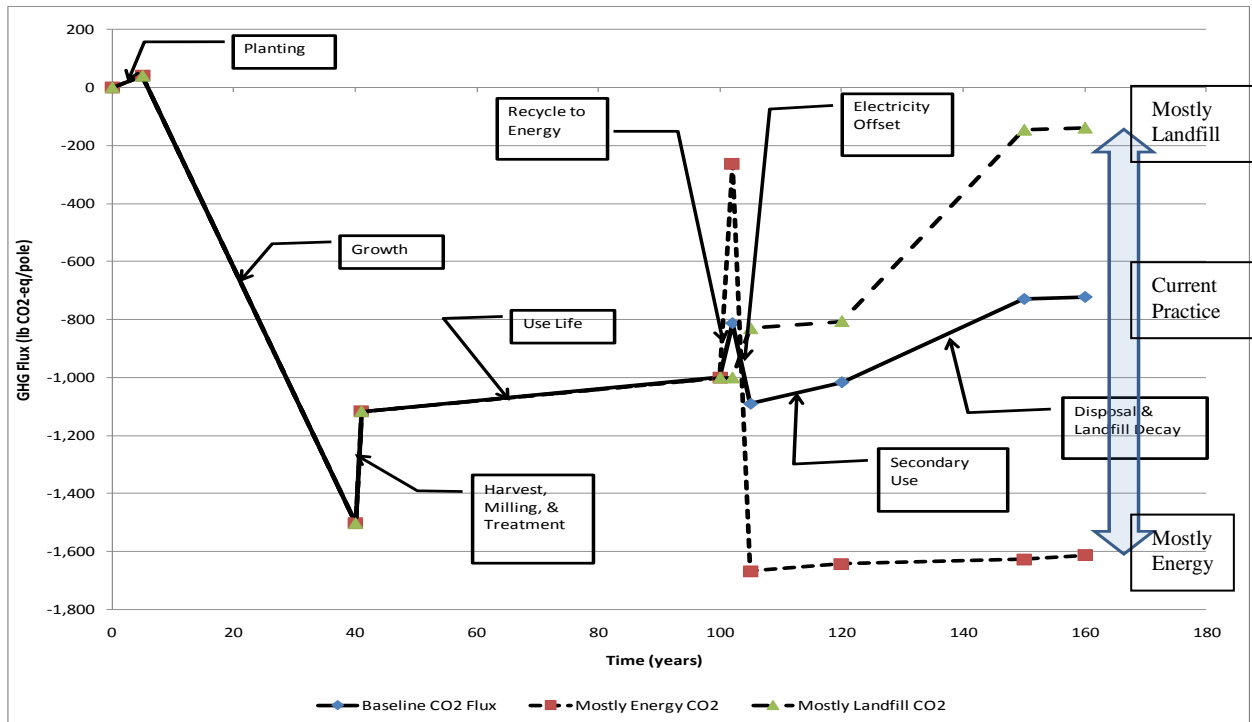


Figure 3-Wood Pole GHG Flux Scenarios

## Conclusions

Pentachlorophenol treated utility poles result in lower environmental impacts than concrete, steel, and fiber reinforced composite poles in six of seven categories, but are higher in one category.

Only treated wood utility poles result in net **lower** GHG atmospheric levels. Use of any other non-wood utility poles **increases** GHG levels.

GHG emissions and energy use may be further reduced if more wood product is recycled for energy production instead of being disposed in landfills.