CARBON IMPACTS OF WOOD PRODUCTS



The release of carbon dioxide (CO₂) 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 CO₂ gas when the material is burned for energy. Because CO₂ 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:



A

Manufacturing Carbon

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

В

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 (CO₂) 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.

Е

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.

Product Units & Notes Carbon from Teacher from Teacher from Teacher from Surred in the Teacher from Teacher from Surred in the Teacher from T	Carbon I	Carbon Impacts of Wood Products	od Products	∢	m	O		Q	A-B-C-D = E
One board foot NENC region 0.9 0.6 1.8 2.6 PNC (plasts) noding One board foot (12 X/2 X/1) (12 X/2 X/1) Southeast region 1.1 0.8 1.8 2.6 PNC (plasts) noding One 2x4 stud of the sat region 1.1 0.8 1.2 6.6 7.0 steel stud noding One door Solid stip fronting 1.1 0.7 2.1 0.0 winyl One door Solid stip fronting 1.1 0.7 2.1 0.0 winyl One door for door Solid stip fronting 1.1 0.7 2.2 0.0 winyl One door for teated pine 5.2 1.7 6.0 77.7 20.4 winyl One 4/5 pole Phartachlorophenol- residence of the stream reduceder 5.2 4.1 2.5.5 7.0 3.4.7 7.0 page door One 4/5 pole Phartachlorophenol- residence of pole stream reduceder 1.0 4.4 2.5.5 7. noa One 4/5 pole Phartachlorophenol- residence of pole stream reduceder	50	<u>=</u>	o Notes	Carbon¹ released	Carbon from bio-fuel used in	Carbon stored in the	Substit (fossil carbon em the wood inst	tution carbon issions avoided by using ead of an alternative)	TOTAL CARBON FOOTPRINE
One board foot (12x12x13) NENC region 1.1 0.8 1.8 2.6 PVC (plastic) modified One 2x4 stud (2x12x13) Southeast region 1.1 0.8 1.2 6.6 7.0 Reel stud modified One 2x4 stud (3x12x12) Southeast region 3.9 3.3 8.4 7.0 Steel stud (3x12x12) 8.4 7.0 Steel stud (3x12x12) 8.4 7.0 Steel stud (3x12x12) 8.4 7.0 8.4 8.4 7.0 8.4 8.4 7.0 8.4 8.4 7.0 8.4 8.4 7.0 8.4 8.4 9.0 9.4			8 9 9 9 9 9 9 9 9 9 9	during manufacture	manufacturing (wood energy)	wood product		Alternative	values represent a carbon credit)
One 2x4 'stud* Southeast region 1.1 0.8 1.2 6.6 7.0 steel stud One 2x4 'stud* Southeast region 3.9 3.3 8.4 7.0 steel stud One door Solid strip flooring 1.1 0.7 2.1 0.0 winyl One door Solid wood 4.6.5 29.4 100.4 228.1 steel door One door Solid wood 4.6.5 29.4 100.4 228.1 steel door One door Solid wood 4.6.5 29.4 100.4 228.1 steel door One door Solid wood 4.6.5 29.4 100.4 228.1 steel door One door Solid wood 4.6.5 29.4 100.4 228.1 steel door One 45 pole Penwe 5.2 1.7 160.4 1377.1 connecte pole One 45 pole Penw 5.7 4.1 25.5 - n/a Southeast region 10.1 4.1 2.5	Hardwood Limber	One board foot	NE/NC region	0.9	9.0	1.8	2.6	PVC (plastic)	-4.2
One 2x4 stud* Southeast region 3.9 3.3 8.4 7.0 steel stud 11 Southeast region 3.9 3.3 8.4 7.0 Avinyl 111 Southeast region 1.1 0.7 2.1 0.0 vinyl One door Solid wood 46.5 29.4 100.4 228.1 steel door One deck board ACO- treated pine 5.2 1.7 16.1 11.9 wood-plastic composite One deck board ACO- treated pine 5.2 1.7 16.1 11.9 winyl One 4% boil Pentachlorophenol- 454.5 430.9 1160.4 1377.1 connocate pole One 4 x 8' sheel 38° Southeast region 10.1 6.5 30.9 - nra One 6 x 8' sheel 38° Southeast region 10.1 6.5 30.9 - nra One 16' long, to fo' long Southeast region 33.0 - nra nra		(12"x12"x1")	Southeast region	#	0.8	1.8	2.6	molding	-4.1
One door Solid strip flooring treatment and coders are agoin as treatment		=	NE/NC region	1.8	1.2	9.9	7.0		-13.0
1 H2 Engineered wood 1.1 0.7 2.1 0.0 vinyl One door Solid wood 46.5 29.4 100.4 228.1 steel door One deck board ACO- treated pine 5.2 1.7 16.1 11.9 wood-plastic One 4 x 8' sheet 38" ACO- treated pine 45.45 430.9 1160.4 1377.1 conrete pole One 4 x 8' sheet 38" Southeast region 19.0 10.7 34.7 - n'a One 4 x 8' sheet 38" Southeast region 10.1 6.5 30.9 - n'a One 16 long Southeast region 10.1 6.5 30.9 - n'a One 16 long Southeast region 33.0 22.9 80.0 55.0 n'a	Softwood lumber	One 2x4 'stud'	Southeast region	3.9	3.3	8.4	7.0	steel stud	-14.9
One door Solid wood 46.5 29.4 1.1 -0.1 winy One deck board ACQ- treated pine 5.2 1.7 16.1 11.9 wood-plastic One 45 pole Pentachlorophenol- treated wood 454.5 430.9 1160.4 1377.1 connecte pole One 47 pole treated wood 19.0 10.7 34.7 - n/a One 47 pole treated wood 19.0 10.7 34.7 - n/a One 47 pole treated wood 19.0 10.7 34.7 - n/a One 47 pole treat 38° Southeast region 10.1 6.5 30.9 - n/a One 47 pole sheet 38° Southeast region 10.1 6.5 30.9 - n/a One 16 long, 10° deep joist Southeast region 10.1 6.5 30.9 - n/a One 47 pole (deep joist) streating on the ast region 10.1 6.5 30.9 - n/a	Hardwood	C++ F	Solid strip flooring	T.	0.7	2.1	0.0	lyniv	-1.8
One door Solid wood 46.5 29.4 100.4 228.1 steel door One deck board ACQ- treated pine 5.2 1.7 16.1 11.9 wood-plastic composite One 45 pole Pentachlorophenol- treated wood 454.5 430.9 1160.4 1377.1 concrete pole One 45 pole treated wood sheet 38" Southeast region 19.0 10.7 34.7 - n'a One 45 pole treated wood sheet 38" Southeast region 19.0 10.7 34.7 - n'a One 16' long, 10" deep joist Southeast region 10.1 6.5 30.9 - n'a One 16' long, 10" deep joist Southeast region 33.0 22.8 80.0 55.4 steel joist	flooring	-	Engineered wood	1.0	0.5	11	-0.1	- - - - - - - -	-0.5
One deck board ACO- treated pine 5.2 1.7 16.1 11.9 wood-plastic composite composite 100 ft² Western redcedar 37.7 6.0 77.7 20.4 vinyl One 45' pole treated wood treated wood 454.5 430.9 1160.4 1377.1 concrete pole One 4'x 8' sheet 3/8" Southeast region 19.0 10.7 34.7 - n/a One 4'x 8' sheet 3/8" Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10' deep joist Southeast region 33.0 22.8 18.9 63.9 56.4 steel joist	Doors	One door	Solid wood	46.5	29.4	100.4	228.1	steel door	-311.5
One 4' x 8' sheet 3/8" Southeast region 5.7 6.0 77.7 20.4 vinyl One 4' x 8' sheet 3/8" Southeast region 19.0 10.7 34.7 - n/a One 4' x 8' sheet 3/8" Southeast region 5.7 4.1 25.5 - n/a One 16' long, 10" deep joist Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10" deep joist Southeast region 33.0 22.9 80.0 55.0	Decking	One deck board	ACQ- treated pine	5.2	1.7	16.1	11.9	wood-plastic composite	-24.5
One 45' pole treated wood sheet 3/8" Pentachlorophenol-treated wood treated wood 454.5 430.9 1160.4 1377.1 concrete pole to concrete pole One 4' x 8' sheet 3/8" Southeast region 5.7 4.1 25.5 - n/a One 4' x 8' sheet 3/8" sheet 3/8" Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10" deep joist Southeast region 33.0 22.9 63.9 56.4 steel joist	Siding	100 ft2	Western redcedar	37.7	0.9	7.77	20.4	vinyl	-66.3
One 4' x 8' sheet 3/8" Southeast region 19.0 10.7 34.7 - n/a One 4' x 8' sheet 3/8" Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10" deep joist Southeast region 33.0 22.9 80.0 55.4 steel joist	Wood treated poles	One 45' pole	Pentachlorophenol- treated wood	454.5	430.9	1160.4	1377.1	concrete pole	-1136.8
One 4' x 8' sheet 3/8" Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10" deep joist Southeast region 33.0 22.9 80.0 55.4 steel joist	OSB	One 4' x 8' sheet 3/8"	Southeast region	19.0	10.7	34.7		n/a	-26.3
sheet 3/8" Southeast region 10.1 6.5 30.9 - n/a One 16' long, 10" deep joist PNW 22.8 18.9 63.9 56.4 steel joist 10" deep joist Southeast region 33.0 22.9 80.0 55.0	boomvid	One 4' x 8'	PNW	5.7	4.1	25.5		n/a	-23.9
One 16' long, 10" deep joist PNW 22.8 18.9 63.9 56.4 steel joist 10" deep joist Southeast region 33.0 22.9 80.0 55.0		sheet 3/8"	Southeast region	10.1	6.5	30.9		n/a	-27.3
10" deep joist Southeast region 33.0 22.9 80.0 55.0	Lioiet	One 16' long,	PNW	22.8	18.9	63.9	56.4	etaal ioiet	-59.9
		10" deep joist	Southeast region	33.0	22.9	80.0	55.0	1000 1000	-70.0

1 All "carbon" values are kilograms of CO2. To convert from CO2 to elemental carbon, muliply by 0.27. For comparison, a car produces 8.8 kg of CO2 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.

Data Sources:

Bergman R. and S. Bowe. 2008. Life cycle inventory of hardwood lumber manufacturing in the northeast and north central United States. Module C • Bergman R. and S. Bowe. 2009. Life cycle inventory of hardwood lumber manufacturing in the southeastern United States. CORRIM Final Report. Module L • Bergman R. and S. Bowe. 2009. Life cycle inventory of softwood lumber manufacturing in the northeast and north central United States. Module D • Bergman R. and S. Bowe. 2010. Life-cycle inventory of manufacturing prefinished engineered wood flooring in the eastern United States. • Birdsey, R.A. 1992. Carbon Storage and Accumulation in United States Forest Ecosystems. USDA Forest Service GTR WO-59. • Bolin, C and S. Smith. 2011. Life cycle assessment of pentachlorophenol-treated wooden utility poles with comparisons to steel and concrete utility poles. Renewable and Sustainable Energy Reviews 15(2011)2475-2486 • Bolin, C and S. Smith. 2011. Life cycle assessment of ACQ-treated lumber with comparisons to wood plastic composite decking. J. of Cleaner Prod. 19(2011)620-629 • Ecolnvent Database • Forest Products Laboratory (FPL). 1999. Wood Handbook: Wood as an Engineering Material. Gen. Tech. Rep. FPL-GTR-113 • Hubbard S. and S. Bowe. 2008. Life cycle inventory of solid strip hardwood flooring in the eastern United States. Module E ● Knight L. et al. 2005. Comparing energy use and environmental emissions of reinforced wood doors and steel doors. Forest Prod. J. 55(6):48-52 • Mahalle L. and J. O'Connor. 2009. Life cycle assessment of western red cedar siding, decking, and alternative products. Used by permissions from FPInnovations – Forintek Division Project No. 6342 • Milota, M., C. West and I. Hartley. 2004. Softwood Lumber - Southeast region. CORRIM Final Report. Module C • Potting J. and D. Block. 1996. Life cycle assessment of four types of floor coverings. J. Cleaner Prod. 3(4):201-213 • Puettmann M. and J. Wilson. 2005. Life cycle analysis of wood products: Cradle-to-gate LCI of residential wood buildings materials. Wood and Fiber Science. 37 CORRIM Special Issue, 2005, 99.18-29 • US LCI Database: PVC, fuels, electricity, transportation • Code of Federal Regulations at 40 CFR 600.113-78 • Product technical information, Steel Stud Manufacturers' Association. www.ssma.org • Wilson, J. and E. Dancer. 2004. Composite I-joists - Pacific Northwest and Southeast. CORRIM Final Report. Module F

Prepared by:

Rick Bergman - Forest Products Laboratory

Maureen Puettmann - WoodLife Environmental Consultants

Adam Taylor - University of Tennessee





The work upon which this publication is based was funded in whole or in part through a grant awarded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, U.S. Forest Service.

In accordance with Federal law and U.S. Department of Agriculture policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age or disability. To file a complaint of discrimination, write USDA Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue SW, Washington, DC 20250-9410 or call 202-720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.