FACT SHEET

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CORRIM Report on Environmental Performance Measures for Renewable Building Materials

The Consortium for Research on Renewable Industrial Materials (CORRIM) was created as a not-for-profit consortium by 15 research institutions to update and expand a 1976 report by the National Academy of Sciences on the impacts of producing and using renewable materials.

The original report focused on energy impacts. Since then, a variety of environmental issues and energy-related concerns have surfaced, but little scientific or quantifiable information has been gathered. Without a scientifically sound database of environmental and economic impacts associated with using renewable materials, it is difficult for policymakers to make informed decisions affecting the forestry and wood manufacturing industries. Moreover, individual industries, including those that use wood as a raw material, have little information to provide a basis for strategic planning and investments to improve their environmental stewardship.

The new CORRIM report provides a database of information for quantifying environmental impacts and economic costs of wood building materials through the stages of tree planting, growing, product manufacturing, building construction, and its operational use and demolition. Comparisons between several wood and non-wood materials used in home construction are assessed, showing generally that wood framing is more environmentally friendly than steel or concrete and that many opportunities exist for improved performance.

Future research is planned to provide a component-by-component assessment of environmental impacts to assist in making building design changes that can improve performance. The geographic and product coverage will be expanded along with a broader range of building designs in order to identify more opportunities for improved performance.

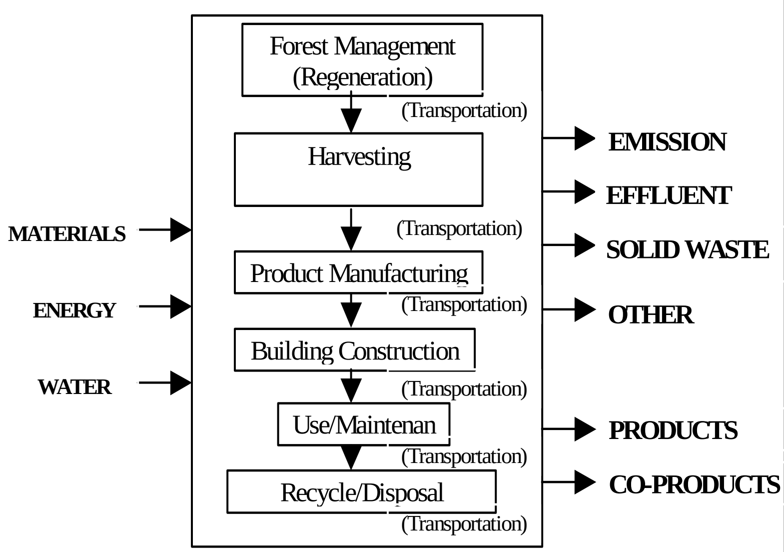
Using wood in more applications that substitute for fossil-intensive products can substantially improve environmental performance. Wood offers unique opportunities to store carbon in the forest, products, and substitution (avoided fossil intensive products), while also supporting other ecological services such as clean water, clean air, habitat, and recreation.

Motivation for Creating CORRIM

Public interest in the environmental impacts of forest management has reached new heights, resulting in a demand for strategies and policies to improve environmental performance. Unfortunately, environmental consequences of changes in forest management, product manufacturing, and construction are poorly understood, resulting in policies that may be detrimental to global environmental quality. This situation is greatly accentuated by an almost total lack of up-to-date, scientifically sound, product life-cycle data in the United States, particularly life-cycle data regarding wood and bio-based products.

Concerns about forests and wood products have a direct and significant impact on U.S. building materials and home building industries. Harvest

Figure 1 – Life cycle from regeneration of trees to disposal of wood materials



reductions are quickly reflected in the availability of wood, and in turn, the price of building materials. This triggers consumers to import wood from other countries or to use non-wood substitutes. The environmental consequences of these changes in material flow and uses are generally ignored given the lack of useful data.

Decisions that discourage the use of wood are made each day at all levels of industry and government. While decisions may be motivated by a desire to protect the environment, the negative consequences associated with using non-wood substitutes are often not considered.

The decision to avoid using wood building materials may in fact be counterproductive to the intent. It is critical that a better information base of quantitative data regarding the environmental impacts of a variety of building products be developed.

Mission

The CORRIM research plan proposed to develop a scientific base of information relating to environmental performance of wood-based building products. The plan identifies management, manufacturing, and construction methods to increase carbon sequestration, improve the efficiency of manufacturing processes, reduce waste and potentially toxic materials, and sustain healthy forest ecosystems.

The intent provide the following outcomes:

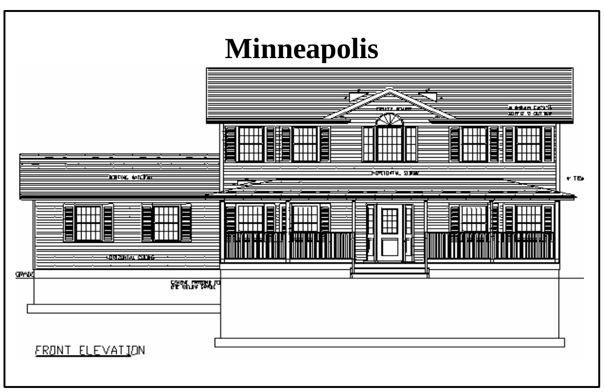
- A consistent database to evaluate the environmental performance of wood and alternative materials from resource regeneration or extraction, to end use and disposal (i.e., from “cradle to grave”) (Figure 1).
- A framework for evaluating life-cycle environmental and economic impacts.
- Source data freely available for many users, including resource managers, manufacturers, architects, engineers, environmental protection and energy analysts, and policy specialists.
- An organizational framework to obtain the best scientific review.

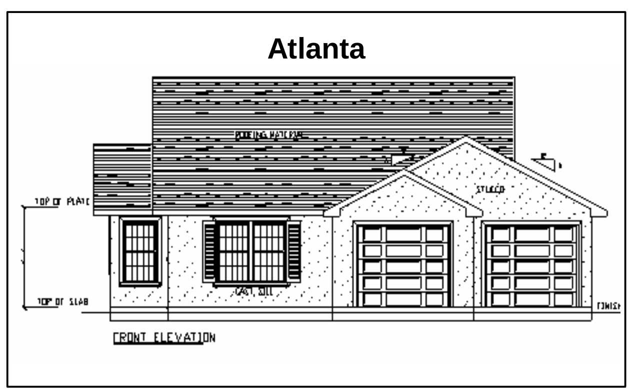
Methodology

CORRIM published a 22-module research plan and protocol in 1998 to develop a life-cycle assessment (LCA) of all environmental inputs and outputs for residential structures and other uses of wood. Research was begun on the first six of those modules in 2000, targeting Pacific Northwest and Southeast supply regions of the United States; lumber, plywood, oriented strandboard (OSB), glulam, laminated veneer lumber (LVL), and I-joist wood products; and typical houses for a warm climate (Atlanta) and a cold climate (Minneapolis).

Primary data were collected from producing mills, and virtual houses were designed to code and practice and analyzed using different building materials in the framing and sheathing. Steel and wood framing were compared in Minneapolis, and concrete and wood in Atlanta. Within-wood substitution examined the use of OSB as the alternative for plywood, green lumber for dry, and I-joists for dimension lumber in floors.

The large numbers of emission and waste outputs were reduced to several environmental performance indexes including the following: air and water emissions, global warming potential, and solid waste, along with measures of energy and material resource consumption.





Results: Table 1 presents the summary environmental performance indexes for typical Atlanta and Minneapolis houses built to code, showing that, with two exceptions, all the index measures had considerably lower environmental risk for the wood frame designs in Atlanta and Minneapolis compared with the non-wood frame designs. The steel and wood designs produced similar solid waste in Minneapolis, and the concrete and wood framing designs in Atlanta produced similar water pollution.

Table 1 – Environmental performance indices for residential construction.

	Wood frame	Steel frame	Difference	Steel vs. wood (% change)		Wood frame	Concrete frame	Difference	Concrete vs. wood (% change)
Minneapolis Home					Atlanta Home				
Embodied energy (GJ)	651	764	113	17%	Embodied energy (GJ)	398	461	63	16%
Global warming potential (CO_2 kg)	37,047	46,826	9,779	26%	Global warming potential (CO_2 kg)	21,367	28,004	6,637	31%
Air emission index (index scale)	8,566	9,729	1,163	14%	Air emission index (index scale)	4,893	6,007	1,114	23%
Water emission index (index scale)	17	70	53	312%	Water emission index (index scale)	7	7	0	0%
Solid waste (total kg)	13,766	13,641	-125	-0.9%	Solid waste (total kg)	7,442	11,269	3,827	51%

The substitution of steel or concrete for wood in framing involves as little as 6-10% of the mass of a house because so many components are common, such as cement foundations, windows, gypsum covering, and roofs. Even so, the change in environmental performance is much greater. Looking only at wall and floor subassemblies results in much worse percentage comparisons for concrete and steel as the amount of common materials are reduced because the roof and foundation are not considered. Substituting OSB for plywood results in a several percent increase in risk for wood framing, but because the resource is coming from lower valued sources, the base of renewable resources is significantly extended. Dry lumber increases the risk indexes over green lumber by several percent. The wood resource used in I-joists is only 65% of the wood used in dimension lumber joists offsetting the increased energy used in OSB as the major component. But the reduced material needed for I-joists increases the material efficiency for wood by 10% compared with dimension lumber floor joists. The environmental performance changes for these within-wood substitutions are all small relative to substituting steel or concrete for wood framing.

Table 2 summarizes the energy used, including the use, maintenance, and demolition phases of the life cycle. The energy used in the structure is much greater than that used for maintenance and demolition. Energy used for heating and cooling is even greater than for construction when looking over the more than 75-year life of a house. However, the present value cost of that energy is much smaller than construction, requiring a time-sensitive investment analysis to select a better tradeoff.

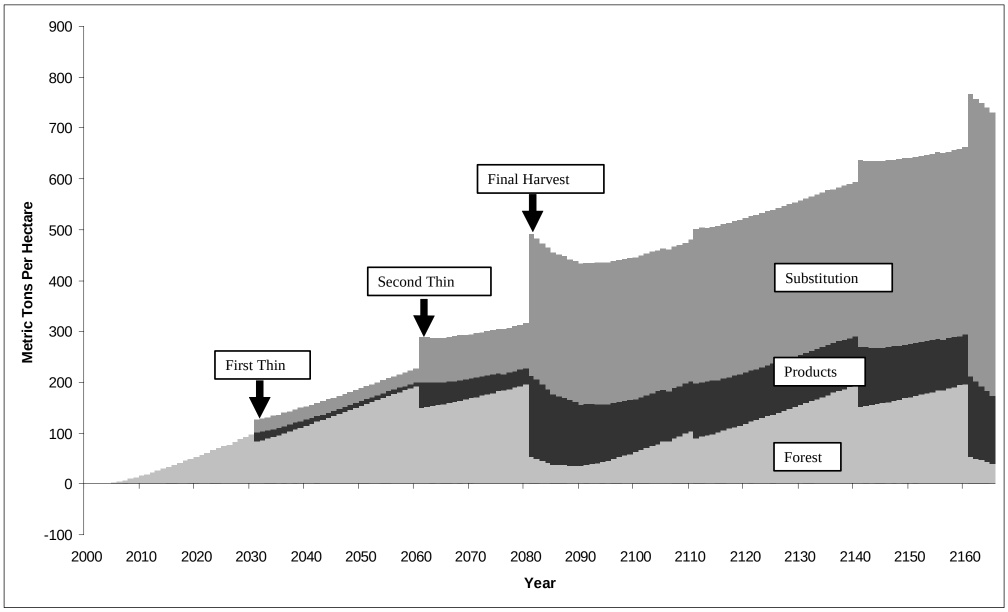
Carbon emissions are an important aspect when using renewable resources. Figure 2 summarizes all carbon pools that are present in the forest as it matures. It also shows that when a forest is harvested, much of the carbon is exported to product pools, with a modest increase of carbon in the combined forest and product pools over time, unlike the steady state that exists in a forest. But of greater importance, as wood products substitute for concrete or steel materials, there is a substantial avoidance of emissions by not using these fossil-fuel-intensive building materials. The combined pools of carbon in the forest, products net of processing including the bioenergy from hogfuel, and the carbon from avoiding fossil-fuel-intensive substitutes show a substantial increasing trend over time, an important consequence for carbon policy.

Table 2 – Energy used in representative building life-cycle stages.

	Minneapolis house		Atlanta house	
	Wood frame	Steel frame	Wood frame	Concrete frame
Energy in the structure (GJ)	646	759	395	456
Energy from maintenance (GJ)	73	73	110	110
Energy for demolition (GJ)	7	7	7	9
Energy subtotal	727	840	512	573
Energy use for heat & cool (GJ) (75 yrs)	7800	7800	4575	4575
House cost	$168,000	$168,000	$135,000	$135,000
Construction cost	$92,000	$92,000	$74,000	$74,000
Cost/yr heat & cool	$692	$692	$491	$491
Present value cost (75 years @ 5%)	$13,490	$13,490	$9565	$9565
% of construction cost	14.7	14.7	12.9	12.9

Because so much carbon is stored in the forest, forest management impacts on carbon are of considerable interest. The impact of longer rotations in the Pacific Northwest were analyzed, and although it was noted that longer rotations over time will sequester more carbon in the forest, when adding the carbon in products and the impact of product substitution, the shorter rotations stored more carbon than did the longer rotations, with the amount of carbon increasing as the time interval of interest is increased (Figure 3). In effect, any delay in producing materials, such as a longer rotation, results in the early use of more fossil-intensive products with high emission, more than offsetting any benefits of storing more carbon in the forest on long rotations. Similarly, increasing management intensity (fertilization and thinning) in the Pacific Northwest increases product output and adds another 20+% to the product and substitution carbon pools as a consequence of the increased and earlier creation of wood products. The intensively managed rotation provided 193 metric tons of carbon per hectare in all pools for a 45-year rotation looking out over an 80-year time interval compared with 164 tons for the less intensive 45-year rotation, with this difference rising to 405 tons versus 360 tons looking out over a 165-year time-interval.

Figure 2 – Carbon in forest, product, and substitution (avoided concrete) pools: 80-year rotation.



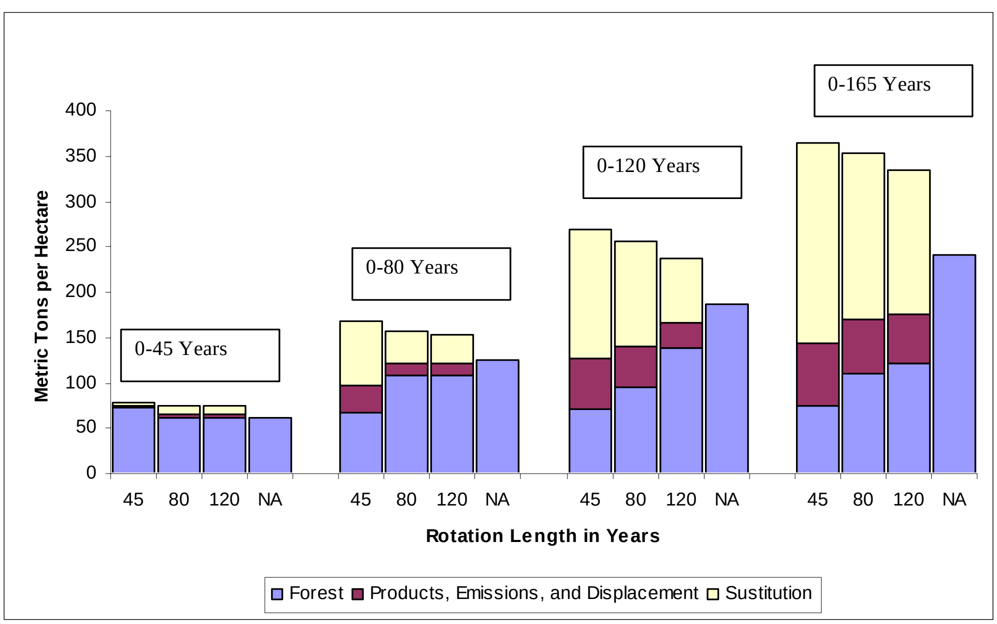


Figure 3 – Average annual carbon in forest, product, and substitution (avoided concrete) pools for different rotations and specified time intervals.

Conclusions

The CORRIM report provides a comprehensive database that can be used for many additional studies to improve on environmental performance and contribute to the establishment of fair environmental assessment and purchasing standards.

- Provides publicly available data and assessments to establish fair and reasonable environmental standards so that wood can compete with other materials when environmentally preferred purchasing standards are used.
- Provides carbon data for trading of carbon credits and certification systems.
- Provides data for assessing the environmental performance of building materials and structures.
- Provides benchmark performance data for forest management, mills, and buildings in order to assess process improvement opportunities such as boilers, dryers, and environmental pollution control improvements based on LCI/LCA impacts
- Identifies opportunities for greater use of engineered wood products using less desirable species and the substitution of less energy-intensive materials for fossil-intensive materials.

Additional Information

CORRIM research has been funded by USDA Forest Service R&D and the Forest Products Laboratory, U.S. Department of Energy, consortium members, and private companies. The results of this research project are available at www.CORRIM.org in a report titled “Life cycle environmental performance of renewable building materials in the context of residential building construction”. A summary article published in the June 2004 Forest Products Journal can also be downloaded. For additional information contact Bruce Lippke at (206) 543-8684, blippke@u.washington.edu, or Jim Wilson at (541) 737-4227, jim.wilson@oregonstate.edu. For Forest Service Information, contact Mike Ritter at (608) 231-9493, mritter@fs.fed.us.

Established in 1910, the mission of the USDA Forest Service Forest Products Laboratory, located in Madison, Wisconsin, is to conserve and extend the country’s wood resources. Today, FPL’s research scientists explore ways to promote healthy forests and clean water and improve papermaking and recycling processes. For more information about FPL, visit our Web site at www.fpl.fs.fed.us. Through FPL’s Advanced Housing Research Center, researchers also work to improve homebuilding technologies and materials; for more information visit the AHRC Web site at www.fpl.fs.fed.us/ahrc/.