INTRODUCTION TO SPECIAL ISSUE

EXTENDING THE FINDINGS ON THE ENVIRONMENTAL PERFORMANCE OF WOOD BUILDING MATERIALS

This compendium provides extensions to the research first reported in the December 2005 Wood and Fiber Science Special Issue (WFS 2005) devoted to CORRIM's Reports on Environmental Performance of Wood Building Materials. The Consortium for Research on Renewable Industrial Materials (CORRIM) is a nonprofit research consortium made up of 15 research institutions dedicated to developing comprehensive environmental performance information on all stages of processing for wood building materials consistent with life-cycle methods and standards (www.corrim.org). That report summarized a 4-yr undertaking to collect all the inputs and outputs for each stage of processing wood products through to the final use of building materials, including forest regeneration, product manufacturing, construction, building use and maintenance, and final disposal or recycling. Life-cycle inventory (LCI) tables were produced for forest regeneration and harvesting in the two major US supply regions—Pacific Northwest (PNW) and Southeast—carried through to the production of softwood lumber, plywood, OSB, glulam beams, LVL, I-joists, and trusses with the processing LCIs based on primary data surveys of a sample from many mills in each region. Life-cycle assessments (LCA) for environmental impacts—energy, global warming potential, air and water pollution, solid waste—were developed for a virtual house built to code in Atlanta, a warm climate, and Minneapolis, a cold climate. A LCA index for ecosystem impacts was developed for sustainable management alternatives for the PNW forests given the substantial efforts in that region to protect species at risk. The primary product database was uploaded to the US LCI database managed by the National Renewable Energy Laboratory (NREL) where one can access the LCI data for nonwood material as well as CORRIM data on wood materials (NREL 2008). A cradle-to-product gate LCI for each product was included in the Wood and Fiber Science Special Issue (pages 18 – 29).

The CORRIM reports provided direct comparisons of the environmental impact of using wood framing vs steel in Minneapolis residential construction and wood framing vs concrete block in Atlanta using the ATHENA® Impact Estimator model to evaluate the impact of the environmental burdens associated with the materials used, their transport, and construction. The Impact Estimator is a model designed to assist architects in estimating the environmental burden resulting from building specifications (www.athenaSMI.ca). These reports summarizing the Phase I research program of CORRIM provided, for the first time since 1976, a comprehensive look at the environmental burdens for wood products in wood-framed buildings. This earlier report leading up to the recent CORRIM reports was sponsored by the National Academy of Sciences and published more than 30 yr ago (National Research Council 1976). A recent analysis of the changes since that very early report was published by Meil et al (2007).

The Phase I research covered only the first 6 of a 22-module Research Plan developed by CORRIM in 1998 (CORRIM 1998). A Phase II Research Plan was then launched to extend product coverage to the Northeast/North Central (NE/NC) region, the Inland West region, and to extend building construction comparisons to Seattle and Los Angeles both with different seismic codes. Two large-volume nonstructural products were also included, particleboard and medium-density fiberboard (MDF), and to increase the quality of impacts generated by the use of resins, an LCI for US-produced resins used in wood composite products was developed. In this special issue, we report on these

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Phase II research findings. This report in effect extends the geographical coverage to all the supply regions in the US and provides more complete coverage for construction alternatives involving different building types and codes. The NE/NC coverage includes both hardwoods and softwoods, including a hardwood flooring module. The Inland West coverage is of particular interest given the increasing fire frequency in that region and the impact of fire on global warming potential, ie carbon-related emissions.

The Phase II research program included two modules that were essentially direct extensions of the data developed in Phase I to make access to the data and impact comparisons more direct. As noted previously, the cradle-to-product gate LCIs (forest generation to product output) for Phase I products were already published in the prior special report, whereas the cradle-to-gate LCIs for the additional Phase II products are included in this report. The LCA impact of using different materials and processes in home construction was evaluated down to the level of each component used in alternative floor and wall designs to better understand the alternatives builders have to improve performance and also to inform product developers of the opportunities that exist for improving product performance (Lippke and Edmonds 2006). We include some extensions to the Phase I product-level LCA comparisons in this report.

Experience gained by observing how the LCI data have been used since the earlier report convinced us that limiting the LCI profile to the impacts from energy consumed and not including the impact of the carbon stored in products was misrepresenting the carbon emission comparisons between the use of wood and fossil-fuel intensive products. Users of the LCI data were not including the carbon stored in the wood when making comparison with nonwood products. For example, the steel-framed Minneapolis house resulted in a 26% increase in global warming potential (GWP) emissions over a wood-framed house just from the impacts of the energy consumed in producing the materials used, but because the carbon in the wood products is stored for the life of the house, including this as an extension to the steady-state carbon stored in a sustainably managed forest results in the steel-framed house producing 120% more GWP emissions than the comparable wood-framed house. Whereas the Phase I report included carbon stored in products in both a carbon tracking module as well as under the steady-state integration of impacts across all stages of processing, the carbon stored in products needs to be directly linked to the product LCI so it is more likely to be used correctly. This protocol change was adopted in Phase II reports. The comparisons are so compelling that we have included an article in this issue that we think completely alters the perspective of the importance of the carbon stored in building materials.

Given the increasing emphasis on reducing carbon emissions, the carbon tracking articles in the Phase I report have been the most controversial. The CORRIM Phase I reports tracked all burdens across all stages of processing making it possible to develop both steady-state and time-dynamic carbon accounts across all carbon pools. Although life-cycle protocols are based on cross-sectional snapshots of current processes in contrast to reflecting the change in processing technology over time, incorporating a time-dynamic epoch analysis of current processing LCIs clearly demonstrates that the storage of carbon in products and the displacement in carbon emissions when wood is used instead of a fossil-fuel intensive substitute results in a steady increase in the carbon stored and emissions displaced from a sustainably managed forest despite no change in carbon in that forest. The time track of the carbon in all pools will most likely exceed the carbon in an unmanaged forest after the first harvest because the carbon displaced by substituting for fossil-fuel intensive products appears to be greater than any losses from the decomposition of forest residuals and short-lived products. Nevertheless, the fact that CORRIM did not study the impact of the uses of mill residuals and chips except as a biofuel to generate processing energy reducing the use of natural gas results in a substantial underestimate of the carbon benefit from using wood. The default assumption of no substitution and very short lives for products from mill residuals such as chips used in paper and fiber products used in packaging and MDF in furniture result in a significant understatement of the carbon stored from the products produced from the forest. A new module to quantify the substitution impacts of furniture, paper, and other fiber products manufactured from the mill residuals produced as a coproduct of solid wood production represents a critical future need for comprehensive accounting.

Also, although it is known that substitution can be influenced by price, and that if wood products are not produced, fossil-fuel intensive products are ready substitutes, the nature of substitution is a complex response to changes in supply and price. CORRIM research demonstrates the impact of substitution at the level of the whole house but limited to only framing materials, which make up only 6 – 10% of the mass of the house. There are many more opportunities for substitution than framing that can lead to increased substitution, especially if the price of fossil-fuel intensive products rises with the price of energy, making fossil-fuel intensive products less competitive.

CORRIM has recently been funded to develop a biofuel collection and processing LCI/LCA analysis, which will fill in the impacts of collecting forest residuals and short-rotation woody crops and perhaps a higher valued use of some mill residuals. CORRIM is also extending the work done on the impact of fire on the Inland West. The impact of fire adds several complications to sustainable management considerations. Because fire risk reduction thinning treatments reduce the risk and rate of fires, they make it possible to capture more carbon in product storage while also substituting for fossil-fuel intensive substitutes. However, if it takes a long time to complete the treatments, the rate of fires is not diminished immediately so both the type of treatment and rate of phasing in treatments affect carbon stored. The fires also impact soil carbon differently than under sustainable management. Some of these impacts were reported in Lippke et al (2008) but are now being extended to include many more forest types and treatment alternatives. Our Phase II module on Inland West forests demonstrates the impact of carbon under both private management objectives, which produce a substantial volume of wood products that substitute for fossil-fuel intensive products and a comparison under federal management objectives that are falling far short of the need for thinning treatments to reduce the risk of fire resulting in releases of vast amounts of stored carbon.

CORRIM research guidelines require conformity to life-cycle protocols, including specification of purpose, functional unit, boundaries, data categories, collection procedures, and quality assessments. Rigorous peer reviews by life-cycle experts were completed in Phase I. Deficiencies were reported in such areas as ranges of uncertainty in the data, sensitivity analysis, and alternative burden allocation procedures and discussed in the completed report (www.corrim.org/reports/2006/final_phase_1/MainReport&ExecSummary.pdf). Phase II research has continued to require strict adherence to life-cycle protocols, but many of the detailed requirements are not repeated in each article.

Whereas the expectation for the continued need for LCI/LCA is clear, because it provides a critical tool to scientifically measure environmental burdens, the growing use and need for LCI/LCA may lead to new arrangements. There are many more players developing the capacity to use LCI/LCA. The use of LCA by others to show that corn–ethanol provided minimal useful energy over that consumed to produce it has substantially increased the acceptance of LCI/LCA as effective analytical tools. The Energy Independence and Security Act of 2007 now requires agencies that want to use synthetic fuels to achieve minimum standards in displacing fossil fuels. These standards will likely support the use of cellulosic ethanol but not support the use of other biomass resources. More importantly, these standards will likely generate substantial change in how we develop data and how carbon markets and other incentives are framed. The emphasis on carbon as an important metric for judging sustainability will likely have a profound effect on our future and provides many opportunities for research as well as investment in improved performance.

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