ENVIRONMENTAL PRODUCT DECLARATION

NORTH AMERICAN WOOD I-JOISTS

AMERICAN WOOD COUNCIL
CANADIAN WOOD COUNCIL

The American Wood Council (AWC) and Canadian Wood Council (CWC) are pleased to present this Environmental Product Declaration (EPD) for North American wood I-joists. This EPD was developed in compliance with ISO 14025 and ISO 21930 and has been verified under UL Environment's EPD program.

The EPD includes Life Cycle Assessment (LCA) results for all processes up to the point that wood I-joists are packaged and ready for shipment at the manufacturing gate. The cradle-to-gate product system includes the cradle-to-gate product systems for LVL, lumber, OSB, the transportation of these inputs to I-joist plants, and I-joist production.

The AWC and CWC represent wood product manufacturers across North America. Our organizations have undertaken numerous sustainability initiatives on behalf of our membership and we are pleased to present this document to show how we are doing. The publication of this EPD, which is based on rigorous LCA research, is our effort to back up with science what we know to be true – that wood products stand alone as a green building material.

Please follow our sustainability initiatives at:
www.awc.org and **www.cwc.ca**

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION

AMERICAN WOOD COUNCIL

Canadian Wood Council | Conseil canadien du bois

This declaration is an environmental product declaration in accordance with ISO 14025. This EPD does not guarantee that any performance benchmarks, including environmental performance benchmarks, are met. EPDs are intended to compliment Type I environmental performance labels. EPDs provide LCA-based information and additional information on the environmental aspects of products and assist purchasers and users to make informed comparisons between products. EPDs are not comparative assertions. EPDs encourage improvement of environmental performance and provide information for assessing the environmental impacts of products over their life cycle. EPDs not based on an LCA covering all life cycle stages, or based on a different PCR, are examples of declarations that have limited comparability. EPDs from different programs may not be comparable.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	American Wood Council and Canadian Wood Council
DECLARATION NUMBER	13CA24184.106.1
DECLARED PRODUCT	North American Wood I-Joists
REFERENCE PCR	FP Innovations: 2011. Product Category Rules (PCR) for preparing an Environmental Product Declaration for North American Structural and Architectural Wood Products, Version 1 (UN CPC 31, NAICS 321), November 8, 2011.

DATE OF ISSUE	July 23, 2013
PERIOD OF VALIDITY	5 years
EXTENSION PERIOD	1 Year (July 23, 2019)
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	FP Innovations PCR confirmed by PCR Review Panel 570 Saint-Jean Blvd. Pointe-Claire, QC Canada H9R 3J9 T 514 630-4100 info@fpinnovations.ca
This declaration was independently verified by Underwriters Laboratories in accordance with ISO 14025 ☐ INTERNAL ☒ EXTERNAL	Loretta Tam, EPD Program Manager
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR	Thomas P. Gloria, Ph. D., Industrial Ecology Consultants

Description of Industry and Product

Description of North American I-Joist Industry

Manufacturers of a number of traditional wood products have expanded their operations over the past few decades to include production of I-joists. Frequently classified as an "engineered wood product," an I-joist combines other wood products as flanges and webs into a new structural product that resembles the letter "I." Many mills and manufacturing facilities have benefited from the market opportunities presented by this strong, but lightweight product, adding good jobs to many rural areas. In 2012, North American wood I-joist manufacturers produced more than 509 million linear feet (155 million linear meters) of I-joists in 26 different facilities.

Statistics indicate that the North American wood I-joist industry has gradually increased its share of the residential floor framing market. Based on estimates provided by manufacturers, I-joists are used as the structural support for approximately 50% of floors in new single-family dwellings. Manufacturers continue to look for ways to reduce the environmental impact of these products, despite existing data that indicates the efficiencies in the manufacturing process.

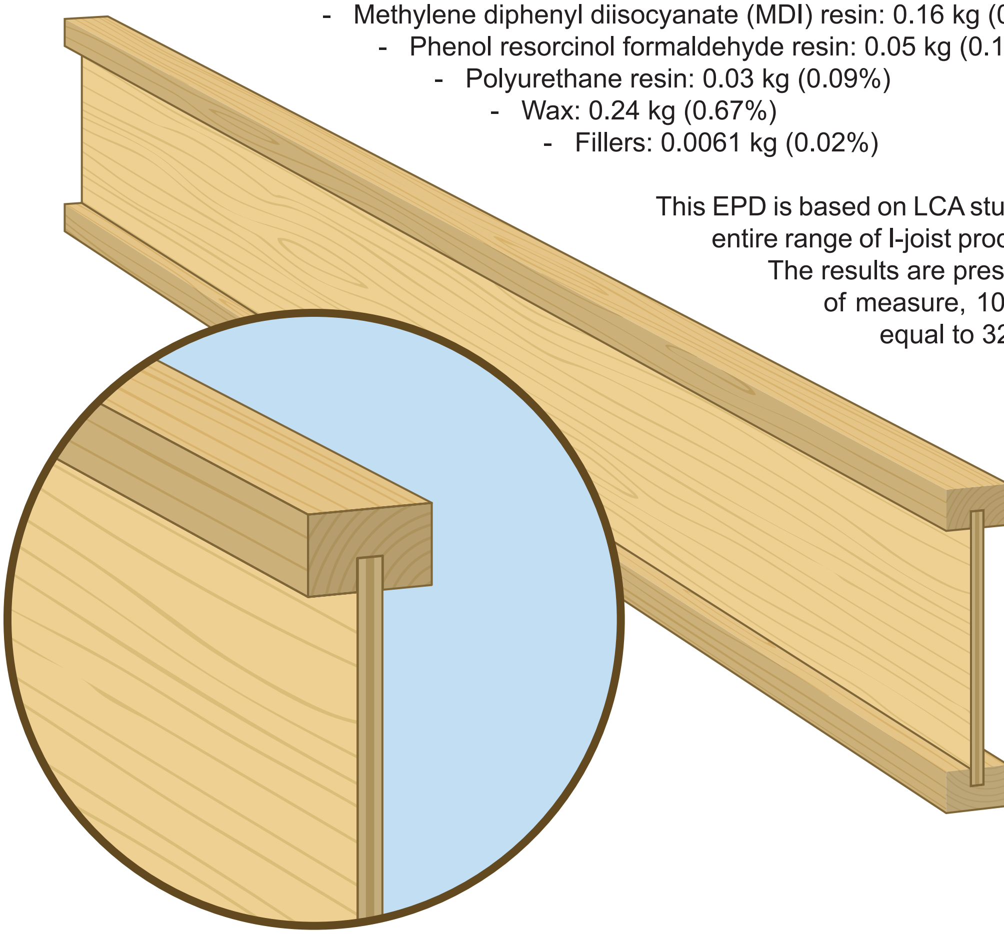
Description of I-Joist Product

The product profile presented in this EPD is for a declared unit of 10 linear meters of wood I-joists. Wood I-joists are manufactured by first manufacturing LVL and lumber that are used as top and bottom "chords," as well as OSB that is used as the "web." The wood components are then cut to specified dimensions, a channel is milled into the chords, and the components are then glued and pressed. The finished I-joist is then packaged for shipment.

Ten linear meters of average North American I-joist weighs 36.44 kg, excluding the variable moisture content. The product composition is presented below and represents the weighted average of the various resin types that are used by different manufacturers:

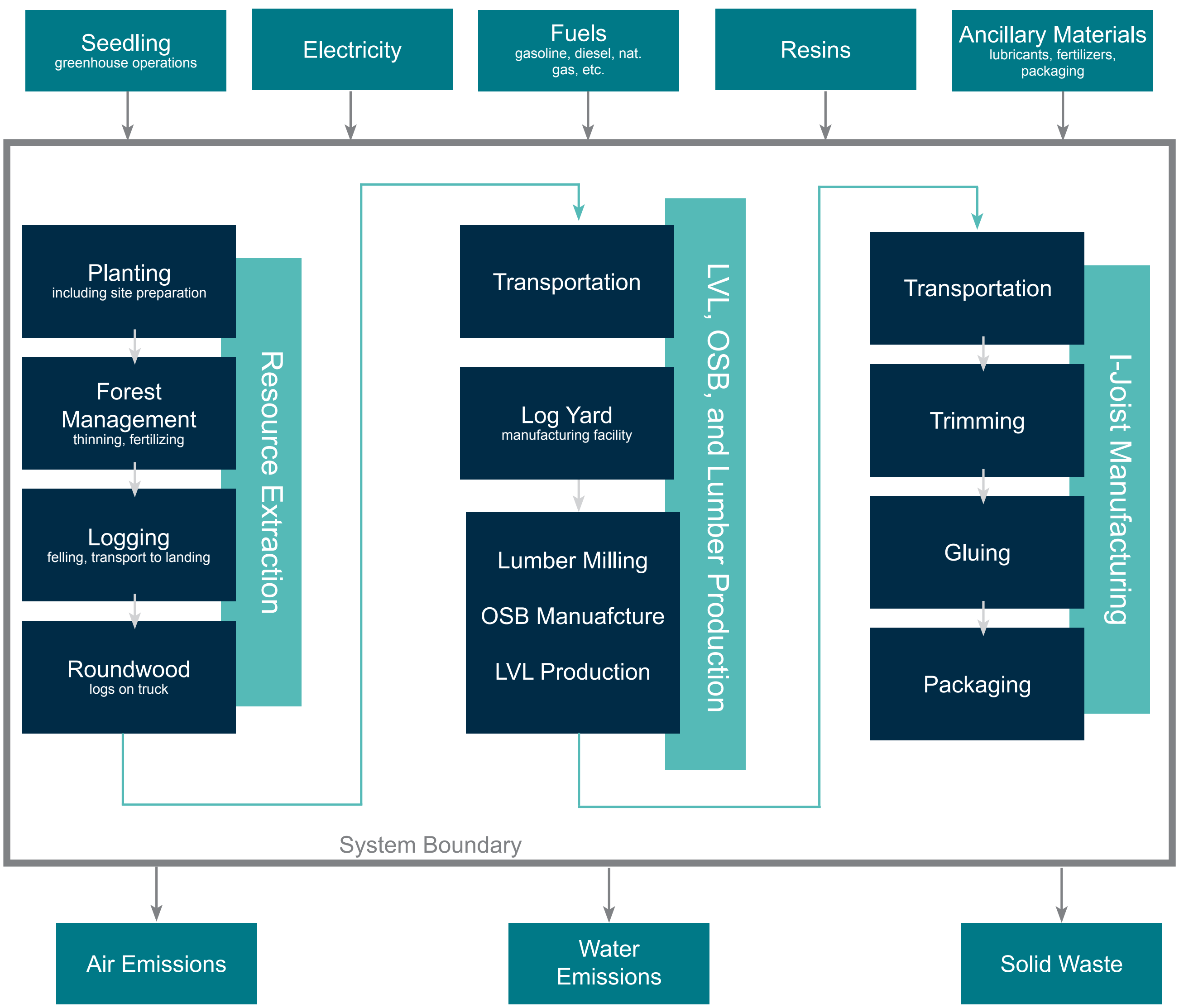
- Wood: 34.99 oven dry kg (96.01%)
- Phenol formaldehyde resin: 0.96 kg (2.65%)
- Methylene diphenyl diisocyanate (MDI) resin: 0.16 kg (0.43%)
- Phenol resorcinol formaldehyde resin: 0.05 kg (0.13%)
- Polyurethane resin: 0.03 kg (0.09%)
- Wax: 0.24 kg (0.67%)
- Fillers: 0.0061 kg (0.02%)

This EPD is based on LCA studies that considered the entire range of I-joist product sizes and functions. The results are presented for the metric unit of measure, 10 linear meters, which is equal to 32.81 feet.



Cradle-to-Gate Life Cycle of I-Joist

Figure 1: Cradle-to-gate product system for I-joist



Business-to-Business EPD and Cradle-to-Gate LCA

Business-to-business EPDs are those that focus on the life cycle up to the point that the product has been manufactured and is ready for shipment, the portion of the life cycle referred to as cradle-to-gate. This EPD includes the cradle-to-gate processes as shown in Figure 1 on the previous page.

The delivery of the product to the customer, its use, and eventual end-of-life processing are excluded from the cradle-to-gate portion of the life cycle. This exclusion limits the accounting of carbon sequestration in the wood product because the benefit of sequestration is not realized at the point of manufacturing, but occurs over the life cycle of the product.

Forest Operations

The assessment of the life cycle impacts of a wood product begins with its origin in natural or managed forests and the energy use and emissions caused by its extraction. Forest management and the reforestation that occurs after extraction are also included. The PCR requires that the cradle-to-gate product system include all forest management activities which may include site preparation, thinning, and fertilization. The forest operations portion of the resource extraction/generation phase also includes the production and planting of seedlings that occur after logging.

Chord and Web Production

I-joist manufacturing requires previously manufactured inputs of LVL, lumber, and OSB. The cradle-to-gate product system of wood I-joists includes the cradle-to-gate product systems of these inputs.

I-Joist Production

The I-joist production phase includes the transportation of inputs to I-joist plants, as well as the I-joist production from LVL, lumber, and OSB. These processes consume electricity drawn from regional grids, fossil fuel, and internally generated biomass.

Methodology of Underlying LCA

Declared Unit

The declared unit in this EPD is 10 linear meters of wood I-joist. This is equivalent to 32.81 linear feet. The average density of North American I-joist including resins and excluding moisture content is 36.44 oven dry kg. Wood I-joists produced in North America are understood to have some moisture in the product, while the oven dry unit of measure contains neither free moisture (moisture in cell cavities) nor bound moisture (moisture in cell walls).

System Boundaries

The system boundary begins with the forest management and resource extraction and ends with finished I-joist ready for shipment at the manufacturer. The forest resources system boundary includes planting the seedlings, site preparation, thinning, fertilization, and final harvest. The cradle-to-gate product system also includes the cradle-to-gate product systems for LVL, lumber, and OSB, the transportation of these inputs to I-joist plants, and I-joist production. Seedlings, and the fertilizer and electricity it took to grow them, were also considered in the system boundary.

Cut-Off Rules

The cut-off criteria for flows to be considered within the system boundary are as follows:

- Mass – if a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor.
- Energy – if a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor.
- Environmental relevance – if a flow meets the above two criteria, but is determined (via secondary data analysis) to contribute 2% or more to the selected impact categories of the products underlying the EPD, based on a sensitivity analysis, it is included within the system boundary.

Data Quality

Precision and Completeness

Primary data on raw materials, energy, and emissions were provided by logging operations, lumber, LVL, OSB plants, as well as I-joist manufacturing facilities. Data were based on input purchases, production output, and reported process emissions. All upstream and downstream secondary data were drawn from publicly available databases, primarily the United States Life Cycle Inventory (USLCI) database. The LCA practitioners performed quality control on all secondary data sources to ensure completeness.

All inventory flows were modeled and at no time were data excluded due to application of the studies' cut-off criteria.

Consistency and Reproducibility

To ensure consistency, only primary data as provided by the study participants were used to model gate-to-gate I-joist manufacturing processes. All other secondary data (upstream and downstream) were consistently applied and adaptations to the databases were documented in the LCA reports.

Reproducibility by third parties is possible using the background LCIs documented in the CORRIM and Athena LCA reports.

Temporal Coverage

Primary data collected from the manufacturing facilities related to the product processes of interest are representative for the years 2004-2012. The previously completed LCA models were updated in 2012 to reflect updates in underlying secondary data used to develop the LCI.

Geographical Coverage

The geographical coverage for this study is based on North American (NA) system boundaries for all processes and products.

Treatment of Biogenic Carbon

Biogenic carbon dioxide emissions were accounted as global warming neutral in accordance with the PCR. Under this approach, the carbon dioxide emissions from the combustion of internally generated wood fuels are considered equal to the carbon dioxide uptake in the forest during tree growth.

Crediting carbon sequestration against the global warming potential was excluded as the long term carbon storage is dependent on gate-to-grave processes not considered directly in this EPD. The expected carbon sequestration for average end-use and end-of-life treatment is provided in the section on "Additional Information."

Allocation

Allocation followed the requirements and guidance of ISO 14044:2006, clause 4.3.4, which gives preference to mass-based allocation, and the following description of allocation from the PCR:

- Allocation of multi-output processes shall be based on mass. However, if economic value difference is at least ten times greater between products from a multi-output process, a suitable revenue-based allocation principle shall be applied and these deviations shall be substantiated and readily available for review.

The wood I-joist co-products fall within this 10 times value threshold and were thus allocated on a mass basis.

Aggregation of Regional Results

The LCA results that follow represent the weighted average of three different LCA studies; one for each of the two primary American manufacturing regions and one Canadian average study. The three regions and their weighting relative to the aggregate profile are as follows:

- United States - Pacific Northwest: 20%
- United States - Southeast: 60%
- Canada - National Average: 20%

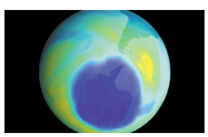
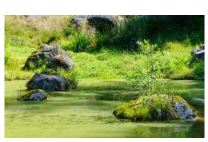
The weighting factors were developed from the relative annual production of the three manufacturing regions. The United States weight is based on the production totals for the years 2001-2009, which is representative of the data vintage that underlies those two studies. The regional weights are based on the production of plywood in the same period as a surrogate for LVL which is the primary material input. The Canadian weight is based on the 2010 production year to represent the more recent data that was used in that study. The selection of 2010 for the Canadian weighting is also conservative because North American I-joist production was lower in that year than in the preceding years. This means that the potential Canadian impacts, which are generally lower than those of the American regions, is weighted less than if the same production years were selected for all weight derivations.

In addition to calculating weighted average impact assessment results, these weighting factors were also used to calculate the weighted average density of North American I-joists. All other values presented in this EPD also utilize this weighting.

Life Cycle Assessment Results

The life cycle impact assessment (LCIA) establishes links between the life cycle inventory results and potential environmental impacts. In the LCIA, results are calculated for impact category indicators such as global warming potential and smog potential. These impact category indicator results provide general, but quantifiable, indications of potential environmental impacts. The various impact category indicators and means of characterizing the impacts are summarized in the table below. Environmental impacts are determined using the TRACI 2 method. These five impact categories are reported consistently with the requirements of the PCR.

Table 1: Impact Assessment Categories

Impact Category Indicators		Characterization Model
Global Warming Potential		Calculates global warming potential of all greenhouse gasses that are recognized by the IPCC. The characterization model scales substances that include methane and nitrous oxide to the common unit of kg CO_2 equivalents.
Ozone Depletion Potential		Calculates potential impact of all substances that contribute to stratospheric ozone depletion. The characterization model scales substances that include CFCs, HCFCs, chlorine, and bromine to the common unit of kg CFC-11 equivalents.
Acidification Potential		Calculates potential impacts of all substances that contribute to terrestrial acidification potential. The characterization model scales substances that include sulfur oxides, nitrogen oxides, and ammonia to the common unit of H^+ moles equivalents.
Smog Potential		Calculates potential impacts of all substances that contribute to photochemical smog potential. The characterization model scales substances that include nitrogen oxides and volatile organic compounds to the common unit of kg O_3 equivalents.
Eutrophication Potential		Calculates potential impacts of all substances that contribute to eutrophication potential. The characterization model scales substances that include nitrates and phosphates to the common unit of kg N equivalents.

Cradle-to-Gate Impact Assessment Results

The impact assessment results are shown in Table 2. This LCIA does not make value judgments about the impact indicators, meaning that no single indicator is given more or less value than any of the others. All are presented as equals. Additionally, each impact indicator value is stated in units that are not comparable to others. Some variations exist between the three underlying data sets and are a result of differences in regional energy mixes, particularly the sources of electricity, as well as differences in production practices and efficiencies.

The results presented below indicate the potential impacts caused by the cradle-to-gate production of I-joist. Ozone depletion was below 10^{-5} kg CFC-11 eq. in all three of the LCA studies and is thus not reported in the results table. Water consumption was estimated for Canada as required by the PCR. However, the U.S. regional estimate includes all water withdrawals without netting out non-consumptive use. As a result, the combined weighted average overstates total water consumption and is therefore conservative.

Table 2: Cradle-to-Gate Impact Assessment Results - 10m North American I-joist

Impact category indicator	**Unit**	**Total**	**Forestry operations**	**Chord & web production**	**I-joist production**
Global warming potential	kg CO_2 eq.	16.74	0.84	12.28	3.62
Acidification potential	H+ moles eq.	8.64	0.56	6.42	1.66
Eutrophication potential	kg N eq.	0.0071	0.0019	0.0038	0.0013
Ozone depletion potential	kg CFC-11 eq.	0.0000	0.0000	0.0000	0.0000
Smog potential	kg O_3 eq.	2.20	0.28	1.52	0.40
Total primary energy consumption	**Unit**	**Total**	**Forestry operations**	**Chord & web production**	**I-joist production**
Non-renewable fossil	MJ	281.03	15.02	205.96	60.05
Non-renewable nuclear	MJ	37.63	0.14	28.73	8.76
Renewable, biomass	MJ	200.31	0.00	195.91	4.40
Renewable, other	MJ	10.23	0.02	6.13	4.08
Material resources consumption	**Unit**	**Total**	**Forestry operations**	**Chord & web production**	**I-joist production**
Non-renewable materials	kg	0.16	0.00	0.08	0.08
Renewable materials	kg	44.95	0.00	44.95	0.00
Fresh water	L	36.13	0.38	25.90	9.85
Non-hazardous waste generated	**Unit**	**Total**	**Forestry operations**	**Chord & web production**	**I-joist production**
Solid waste	kg	2.31	0.01	2.03	0.26

Impact Assessment Results by Life Stage

The two graphs below show that the manufacturing of the chord and web components are the primary driver of impacts in the cumulative cradle-to-gate product system. Chord and web production consumes 73% of fossil fuels and 98% of biomass energy, which drive the impacts in every category.

Figure 2: Cradle-to-Gate Impact Assessment Results

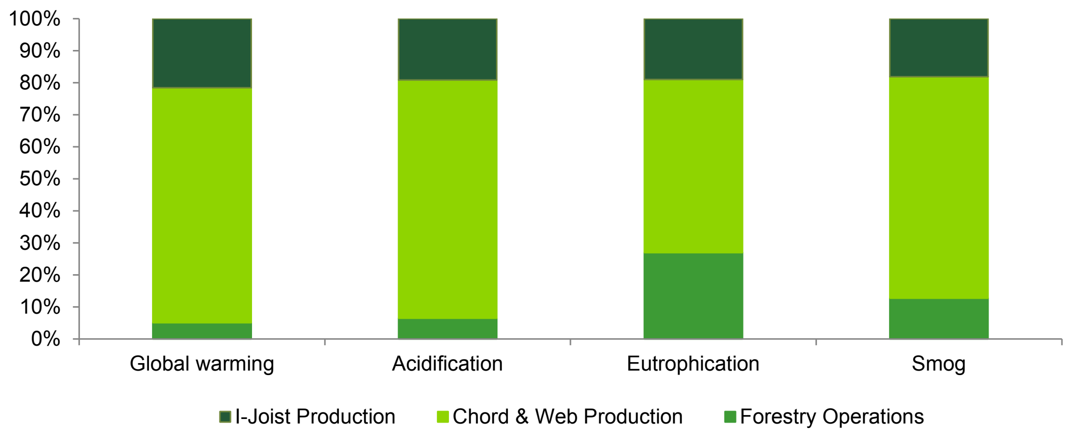


Figure 3: Cradle-to-Gate Primary Energy Consumption

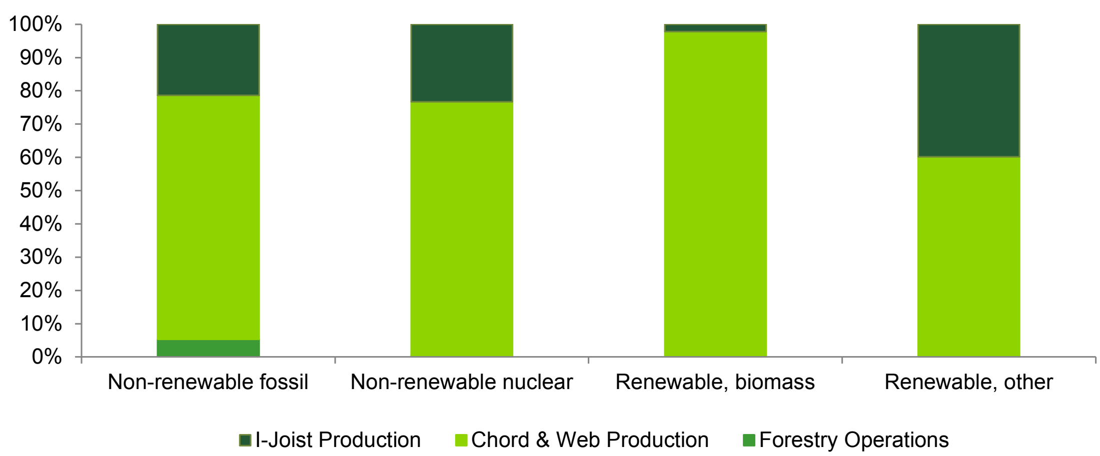


Figure 4: Cradle-to-Gate Energy Use

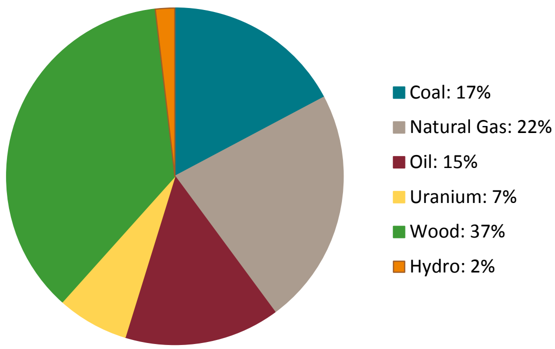


Figure 5: Forestry Operations Energy Use

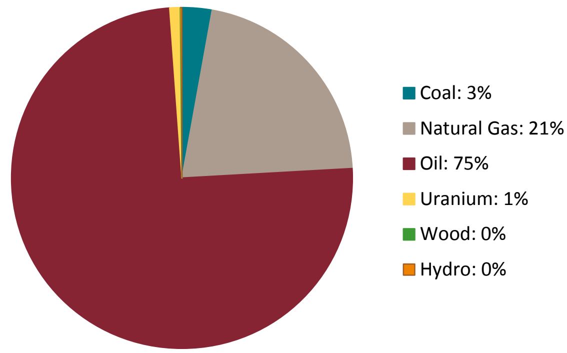


Figure 6: I-Joist Production Energy Use

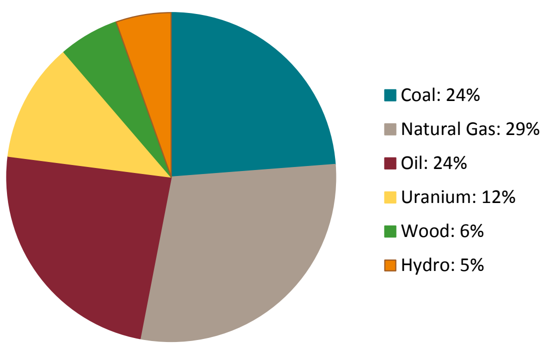
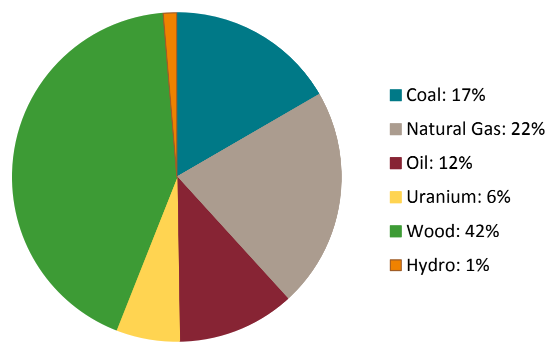


Figure 7: Chord & Web Production



Primary Energy Consumption by Resource

The four pie charts show the consumption of various energy resources in the cradle-to-gate portion of the life cycle. The cradle-to-gate and chord and web production charts show similar results, as manufacturing the inputs consume the bulk of cradle-to-gate energy.

The forest operations portion of the life cycle relies heavily on oil-based energy as consumed in the form of diesel by heavy machinery. Oil accounts for 75% of energy resources consumed in forestry operations.

A significant portion of the energy requirement in manufacturing the chord and web components is met by renewable energy sources, including 42% from biomass and 1% from hydropower. This translates to 37% of cradle-to-gate energy use for biomass and 2% for hydropower. The biomass consumption is due to the kiln-drying processes, while the hydropower use is due to electricity that is consumed throughout the cradle-to-gate product system. Coal, natural gas, oil, and nuclear compose the remaining energy use.

Additional Information

Range of Applications

Wood I-joists are used exclusively in residential and non-residential construction. I-joists are somewhat unique amongst wood products in that they are most commonly used in non-residential commercial construction.

The breakdown of I-joist end uses in North America are as follows:

- New single family residential construction: 60%
- New multifamily residential construction: 15%
- Other construction, upkeep, and improvement: 11%
- Export: 14%

Source: APA - Engineered Wood Association (2012) Structural Panel and Engineered Wood Yearbook, APA Economics Report E178.

Carbon Sequestration

The PCR requires that carbon sequestration may only be credited to the product if the end-of-life fate of that carbon is considered in the LCA study. FPInnovations has recently published a carbon sequestration calculation tool that estimates the emissions from typical end-of-life treatment of wood products that includes recycling, combustion, and landfilling. The carbon sequestered in the product at the manufacturing gate serves as the basis for such an analysis and is as follows (all conversion factors and assumptions are documented in carbon tool):

10m wood I-joists = 34.99 oven dry kg = 17.49 kg Carbon = 64.15 kg CO_2 eq.

This initial carbon sequestration may then be considered against its emission as the I-joist product reaches the end of its service life in various applications. The FPI carbon tool is used to estimate the biogenic carbon balance at year 100, including service life estimations for various applications and the average landfill decay rate. The carbon tool gives the following results:

Carbon sequestered in product at manufacturing gate:
64.15 kg CO_2 eq. = - 64.15 kg CO_2 eq. emission

Methane emitted from fugitive landfill gas:
0.20 kg CH_4 = 5.04 kg CO_2 eq. emission

Carbon dioxide emitted from fugitive landfill gas and the combustion of waste and captured landfill gas:
14.89 kg CO_2 eq. emission

Carbon sequestration at year 100, net of biogenic carbon emissions:
44.22 kg CO_2 eq. = - 44.22 kg CO_2 eq. emission

References

APA - Engineered Wood Association (2012) Structural Panel and Engineered Wood Yearbook, APA Economics Report E178.

Athena Institute: 2013. A Cradle-to-Gate Life Cycle Assessment of Canadian Wood I-Joist Manufacture.

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FPInnovations and Athena Institute: 2013. Business-to-Business (B2B) Carbon Sequestration Tool for Wood EPD's as per PCR for North American Structural and Architectural Wood Products, Version 1.

ISO 14040:2006. Environmental Management – Life Cycle Assessment – Principles and Framework.

ISO 14044:2006. Environmental Management – Life Cycle Assessment – Requirements and Guidelines.

ISO 21930:2007 – Building and Construction Assets – Sustainability in building construction – Environmental declaration of building products.

TRACI: Tool for the Reduction and Assessment of Chemical and other environmental Impacts: http://www.epa.gov/ORD/NRMRL/std/sab/traci/

USLCI Database: http://www.nrel.gov/lci