

ENVIRONMENTAL PRODUCT DECLARATION

NORTH AMERICAN SOFTWOOD LUMBER

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The American Wood Council (AWC) and the Canadian Wood Council (CWC) are pleased to present this Environmental Product Declaration (EPD) for North American softwood lumber. 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 planed and dry lumber is packaged and ready for shipment at the manufacturing gate; the cradle-to-gate product system includes forest management, logging, transportation of logs to lumber mills, sawing, kiln-drying, and planing.

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





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North American Softwood Lumber

North American Structural and Architectural Wood Products

According to ISO 14025 and ISO 21930

This declaration is an environmental product declaration in accordance with ISO 14025 that describes environmental characteristics of the described product and provides transparency and disclosure of the impacts caused by the product life cycle. 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.



PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	American Wood Council and Canadian Wood Council
DECLARATION NUMBER	13CA24184.102.1
DECLARED PRODUCT	North American Softwood Lumber
REFERENCE PCR	FPIinnovations: 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	April 16, 2013
PERIOD OF VALIDITY	5 years
CONTENTS OF THE DECLARATION	<p>Product definition and information about building physics</p> <p>Information about basic material and the material's origin</p> <p>Description of the product's manufacture</p> <p>Indication of product processing</p> <p>Information about the in-use conditions</p> <p>Life cycle assessment results</p> <p>Testing results and verifications</p>
The PCR review was conducted by:	<p>FPIinnovation</p> <p>PCR confirmed by PCR Review Panel</p> <p>570 Saint-Jean Blvd. Pointe-Claire, QC Canada H9R 3J9 T 514 630-4100 info@fpinnovations.ca</p>
<p>This declaration was independently verified by Underwriters Laboratories in accordance with ISO 14025</p> <p><input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL</p>	<p></p> <p>Loretta Tam, EPD Program Manager</p>
<p>This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR</p>	<p></p> <p>Thomas P. Gloria, Ph. D., Industrial Ecology Consultants</p>





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Description of Industry and Product

Description of North American Lumber Industry

The North American forest product industry is a major contributor to both the American and Canadian economies. Sawmills and wood preservation facilities directly employ more than 130,000 workers across North America and countless others in supporting industries. Many of these jobs are rurally located and are the primary driver of local economies.

The North American lumber industry has weathered unprecedented economic changes in recent years through innovation and expansion into new and emerging markets. Efficiency improvements, beyond simply ensuring competitiveness, continually improve the environmental footprint of wood products. Now, more than ever, we are ready to present this EPD that reflects years of research and demonstrates the hard work we've been doing.





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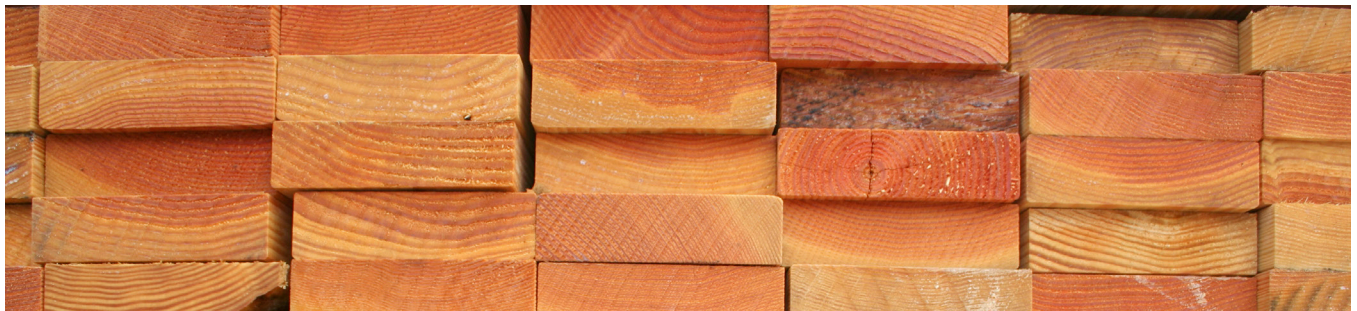
Description of Lumber Product

The product profile presented in this EPD is for a declared unit of 1 cubic meter (0.63 mbfm) of kiln-dried and planed dimension softwood lumber. Softwood lumber is available in a range of “nominal dimensions”, the most common being 2 inches thick by 4 inches wide (2x4) and 2 inches thick by 6 inches wide (2x6), which account for roughly 75% of dimension lumber production in North America. The use of nominal dimensions for lumber is a long-held convention in the industry and describes the size of lumber prior to kiln-drying and planing. The actual dimensions of planed, dry lumber reflect the shrinkage of green lumber in kiln-drying and the material removed during planing, which means that a nominal dimension 2x4 is actually 1.5 inches thick by 3.5 inches wide. The range of nominal and actual dimensions for North American softwood lumber is shown Table 1. Each of these lumber sizes are available in a variety of lengths, the most common lumber product is used as framing studs between 8 and 12 feet.

This EPD is based on an LCA that considered the entire range of softwood lumber sizes and is weighted towards 2x4 and 2x6, which comprise the bulk of production. The results are presented for the metric unit of measure for lumber, 1 cubic meter. This corresponds to 630 board feet (0.63 mbfm), which is a common imperial unit of measure that is widely used in the industry.

Table 1: North American Kiln-dried, Planed Softwood Dimensional Lumber Sizes

Nominal (in)	Actual (in)	Actual (mm)
1 × 2	3/4 × 1 1/2	19 × 38
1 × 3	3/4 × 2 1/2	19 × 64
1 × 4	3/4 × 3 1/2	19 × 89
1 × 6	3/4 × 5 1/2	19 × 140
1 × 8	3/4 × 7 1/4	19 × 184
1 × 10	3/4 × 9 1/4	19 × 235
1 × 12	3/4 × 11 1/4	19 × 286
2 × 2	1 1/2 × 1 1/2	38 × 38
2 × 3	1 1/2 × 2 1/2	38 × 64
2 × 4	1 1/2 × 3 1/2	38 × 89
2 × 6	1 1/2 × 5 1/2	38 × 140
2 × 8	1 1/2 × 7 1/4	38 × 184
2 × 10	1 1/2 × 9 1/4	38 × 235
2 × 12	1 1/2 × 11 1/4	38 × 286
4 × 4	3 1/2 × 3 1/2	89 × 89
4 × 6	3 1/2 × 5 1/2	89 × 140
6 × 6	5 1/2 × 5 1/2	140 × 140
8 × 8	7 1/4 × 7 1/4	184 × 184





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Cradle-to-Gate Life Cycle of Softwood Lumber

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

Business-to-business EPD's 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.

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.

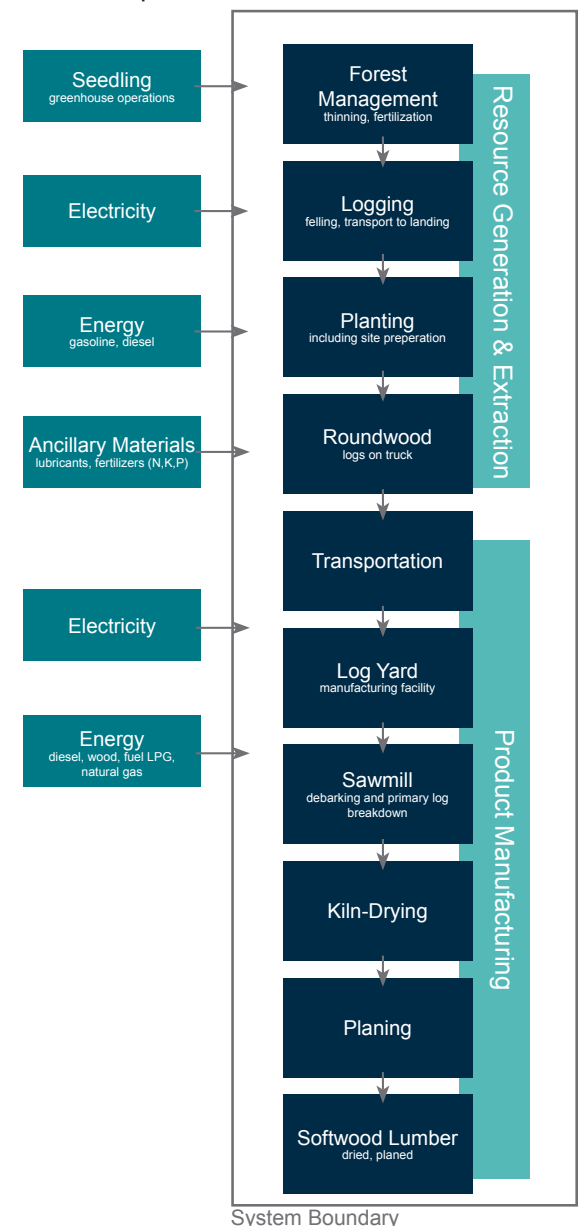
Forest Operations

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 includes 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 occurs after logging.

Lumber Production

The lumber production phase begins with the transportation of logs to the sawmill and includes the unit processes of sawing, kiln-drying, and planing. These processes consume electricity drawn from regional grids, fossil fuel, and internally generated biomass (primarily for kiln-drying).

Figure 1: Cradle-to-gate product system for kiln-dried, planed softwood lumber





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Methodology of Underlying LCA

Declared Unit

The declared unit in this EPD is 1 cubic meter (m³) of planed, kiln-dried softwood lumber. This is equivalent to 630 board feet (0.63 mbfm). The average density of North American softwood lumber is 433.57 oven dry kg/m³. Kiln-dry lumber produced in North America is 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 forest management and resource extraction and ends with planed dry lumber ready for shipment at the manufacturer. The forest resources system boundary includes planting the seedlings, site preparation, thinning, fertilization and final harvest. Lumber manufacturing includes the transportation of logs, rough milling, drying, and planing. 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.



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Data Quality

Precision and Completeness

Primary data on raw materials, energy, and emissions were provided by logging operations and lumber milling facilities, based on input purchases, production output, and reported process emissions. All upstream and downstream secondary data was 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 lumber 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 2004-2009. The underlying 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 dependant 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".



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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 lumber 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 five different LCA studies; one for each of the American manufacturing regions and one Canadian average study. The five regions and their weighting relative to the aggregate profile are as follows:

- United States - Pacific Northwest: 17%
- United States - Southeast: 30%
- United States - Inland Northwest: 11%
- United States - Northeast/North Central: 3%
- Canada - National Average: 39%

The weighting factors were developed from the relative annual production of the five manufacturing regions. The United States regional weights are based on the production totals for the years 2001-2009 which is representative of the data vintage that underlies those four studies. 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 lumber 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 softwood lumber. All other values presented in this EPD also utilize this weighting.


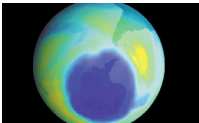





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Life Cycle Assessment Results

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 2: 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 CFC's, HCFC's, 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.





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Cradle-to-Gate Impact Assessment Results

The impact assessment results are shown in Table 3. 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 five 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 indicate the potential impacts caused by the cradle-to-gate production of softwood lumber. Ozone depletion was below 10^{-5} kg CFC-11 eq. in all five 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 estimates include 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 3: Cradle-to-Gate Impact Assessment Results - 1m³ North American Softwood Lumber

Impact category indicator	Unit	Total	Forestry operations	Lumber production
Global warming potential	kg CO ₂ eq.	72.64	10.56	62.09
Acidification potential	H+ moles eq.	42.25	5.43	36.82
Eutrophication potential	kg N eq.	0.0326	0.0123	0.0203
Ozone depletion potential	kg CFC-11 eq.	0.0000	0.0000	0.0000
Smog potential	kg O ₃ eq.	14.51	2.84	11.67
Total primary energy consumption	Unit	Total	Forestry operations	Lumber production
Non-renewable fossil	MJ	1113.01	156.99	956.02
Non-renewable nuclear	MJ	114.48	1.60	112.88
Renewable, biomass	MJ	1578.86	0.00	1578.86
Renewable, other	MJ	60.60	0.27	60.33
Material resources consumption	Unit	Total	Forestry operations	Lumber production
Non-renewable materials	kg	0.11	0.00	0.11
Renewable materials	kg	468.11	0.00	468.11
Fresh water	L	90.02	8.61	81.41
Non-hazardous waste generated	Unit	Total	Forestry operations	Lumber production
Solid waste	kg	14.99	0.10	14.89





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Impact Assessment Results By Life Stage

The two graphs below show that the lumber manufacturing itself is the primary driver of impacts in the cumulative cradle-to-gate product system. Lumber manufacturing consumes 86% of fossil fuels and 100% of biomass energy, which drive the impacts in every category.

Figure 2: Cradle-to-Gate Impact Assessment Results

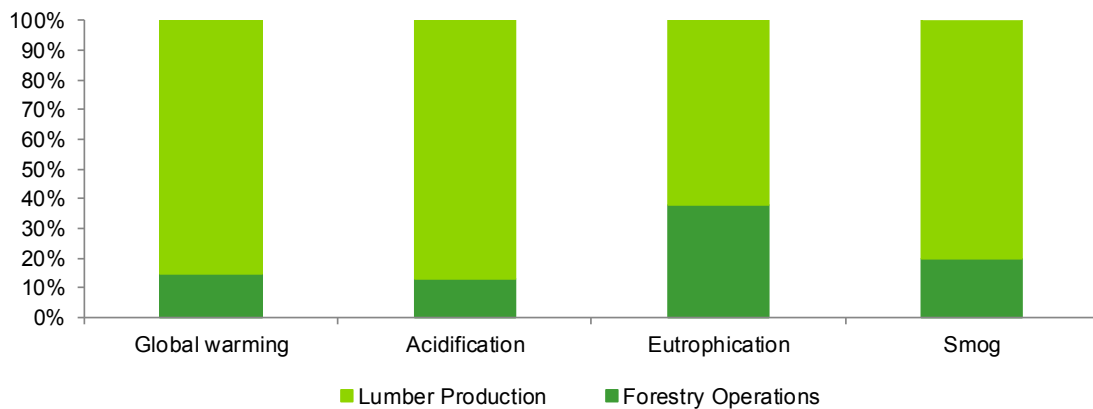
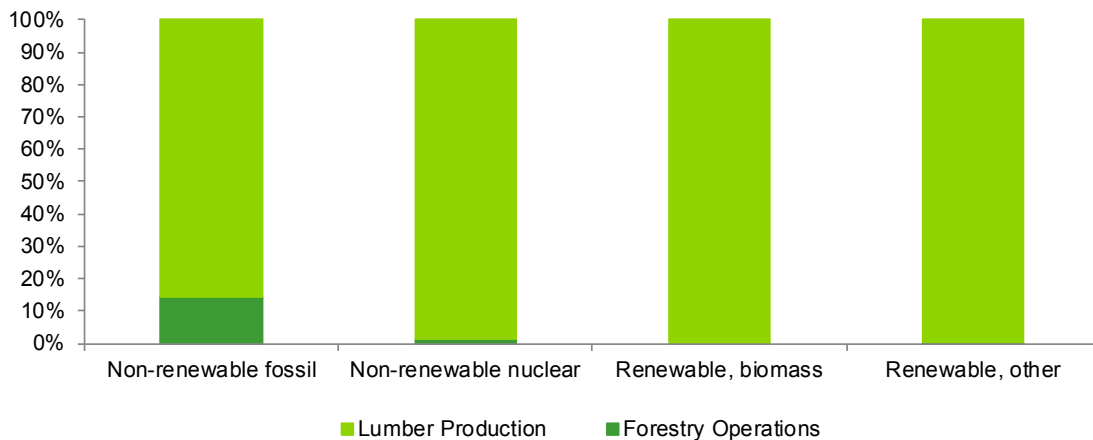


Figure 3: Cradle-to-Gate Primary Energy Consumption





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Figure 4: Cradle-to-Gate Energy Use

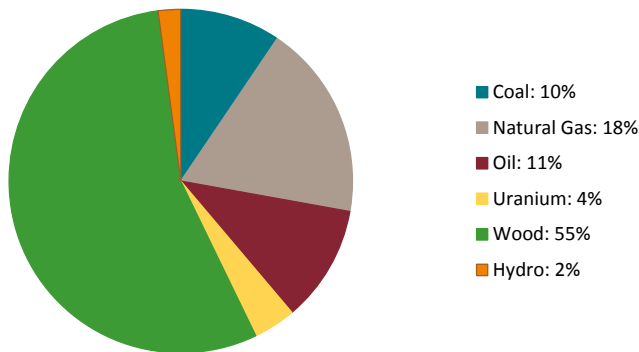


Figure 5: Forestry Operations Energy

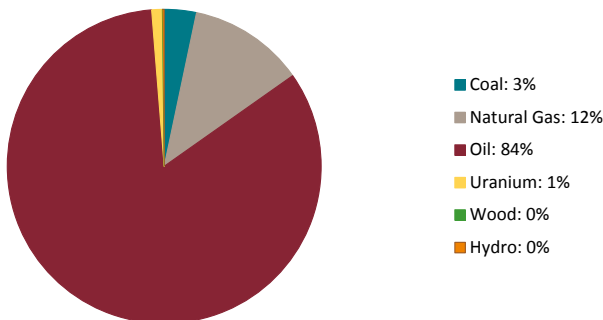
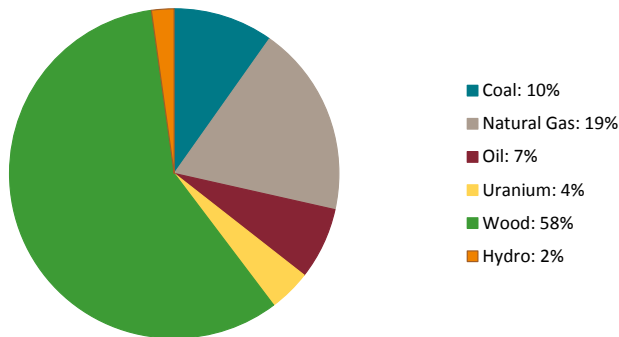


Figure 6: Lumber Production Energy Use



Primary Energy Consumption by Resource

The three pie charts show the consumption of various energy resources in the cradle-to-gate portion of the life cycle. The cradle-to-gate and lumber production charts show similar results as manufacturing consumes 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 84% of energy resources consumed in forestry operations.

More than half of the energy requirement in manufacturing is met by renewable energy sources, 58% from biomass and 2% from hydro power. This translates to 55% of cradle-to-gate energy use for biomass and 2% for hydro power. The biomass consumption is used exclusively in the kiln-drying process while the hydro energy use is due to electricity that is consumed throughout the cradle-to-gate product system. Coal, natural gas, oil, and nuclear comprise the remaining energy use.

The prevalence of renewable energy use in the life cycle of softwood lumber means that only 39% of energy consumption is derived from fossil fuel sources. This means that lumber has a particularly low carbon footprint relative to the energy required for lumber manufacturing.





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Additional Information

Range of Applications

Softwood lumber is a versatile product that is used in a variety of applications. Lumber is most commonly associated with the construction and renovation of single family homes. It is no surprise that commercial and residential construction consumes the greatest share of softwood lumber relative to other uses.

The following lists the breakdown of lumber end uses in North America:

- New single family residential construction: 33%
- Residential upkeep and improvement: 25%
- New non-residential construction: 8%
- Manufacturing furniture and other products: 34%





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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. FPIInnovations 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):

1m³ Softwood Lumber = 433.57 oven dry kg = 216.78 kg Carbon = 794.88 kg CO₂ eq.

This initial carbon sequestration may then be considered against its emission as the lumber 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:
794.88 kg CO₂ eq. = -794.88 kg CO₂ eq. emission

Methane emitted from fugitive landfill gas:
3.22 kg CH₄ = 80.44 kg CO₂ eq. emission

Carbon dioxide emitted from fugitive landfill gas and the combustion of waste and captured landfill gas:
231.39 kg CO₂ eq. emission

**Carbon sequestration at year 100, net of biogenic carbon emissions:
483.05 kg CO₂ eq. = -483.05 kg CO₂ eq. emission**





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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>